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R. H. STINCHFIELD, *Editor*

Editorial Office: 1155 16th Street, N. W., Washington 6, D. C.

VOLUME XXXI NO. 8

TABLE OF CONTENTS, AUGUST-SEPTEMBER 1947

For Better or Worse 3
Jeff Ponders the Prospects

Whole-farm Demonstrations 6
Advocated by C. J. Chapman

Analyzing the Soils of Northwest Louisiana 11
Importance is Stressed by Lester L. Loftin

Minor Plant Nutrients 13
Discussed by H. P. Cooper

Reshaping New England Farm Land 19
A. B. Beaumont Describes Methods

Fertilizing Potatoes Economically in Aroostook County, Maine 23
G. L. Terman and Arthur Hawkins Explain How

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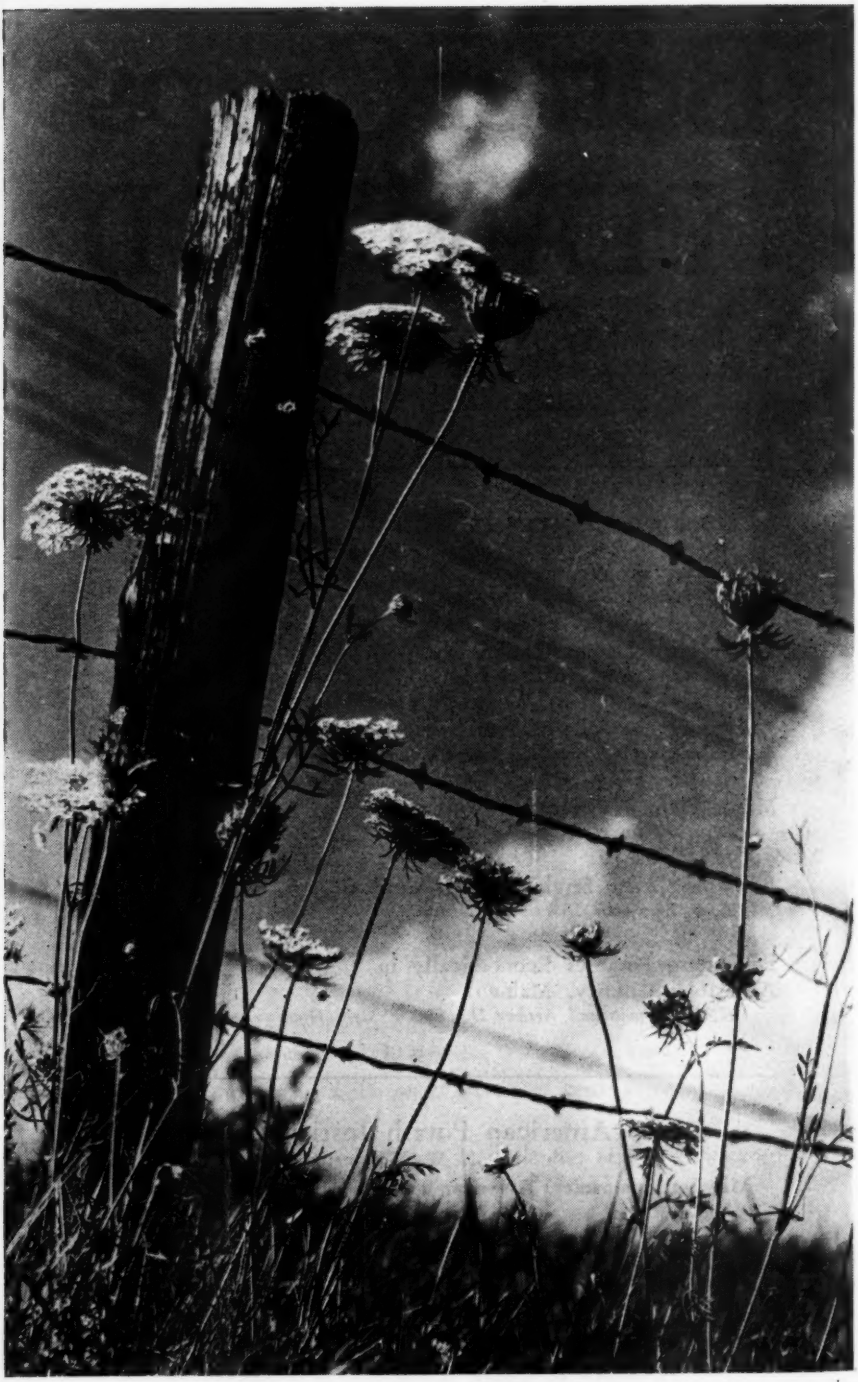

NATURE ATTEMPTS ADORNMENT

Better Crops with PLANT FOOD

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VOL. XXXI WASHINGTON, D. C., AUGUST–SEPTEMBER 1947 No. 8

Facing Life . . .

For Better or Worse

Jeff McDermid

YES, I *do* forget that nuptial anniversary sometimes, but had I been unfortunate in the choice of a life partner I probably would scan the calendar for its approach like a condemned prisoner waiting for his doom. Anyhow, what's such a date when every morning brings another satisfactory day of married companionship?

One who has been thus united through thick and thin with a courageous person of sound mind and sympathetic understanding usually gets a special "lift" out of that part of the wedding ceremony where the young folks join hands and plight their troth "for better or for worse, for richer or for poorer, through sickness and through health, 'til God doth us part." At least I have wanted to blow my nose when the parson got to that part, thinking of all the things it could mean.

To us particularly there have passed about three decades of experiencing life's ups and downs together. On the whole it has been for better, for normal health and comfort, and also for "richer"—in other ways than goods and money at least. The fleeting sick spells, some of them somewhat serious, have only served as the seasoning to make the dish more palatable. It is through them that one learns to sense the value of the simple blessings so often taken for granted and never put on the credit side of the family budget.

Meanwhile we have two photographs laid by to remind us how each of us looked back there in the somewhat distant interval of our first closely associ-

ated teamwork. The young woman looks dainty, demure, and hopeful in her own make of bridal gown, with the glint of confidence in her expression which later years have not always justified. But she has it still, despite my shortcomings.

I even remember the day she posed for it. It was a fortnight after our honeymoon and she tried very hard to arrange the veil and the folds of the gown just as they looked when we stood up together, but she had to be content with a bunch of artificial flowers that the photo property man provided. She turned thumbs down on my idea of sitting in with her for the picture, as she had seen too many corny specimens in old albums, with the groom standing up like Napoleon at the battle of Waterloo, with one hand coyly resting on the slim shoulder of his affianced. Even when I pointed out that it was the handle-bar moustaches of former victims that really spoiled the view, and which I was unable to muster, she still refused.

I glance at that picture every morning as I go in to shave. Then I wonder what she ever saw in a guy with thin, grayish hair, sagging jowls, fine-cut wrinkles induced more by laughter than by strain, and an anterior bulge at the waist line which reflects much good work done by her in the kitchen. So far I haven't had the courage to ask her.

TIME HAS treated her well because she has always had so much of it to give to others. On second thought, I am not sure but that that statement might not stand along with the acceptable quotes from the Saints as a proper tribute to place upon the spot where she finally rests—at some, I trust, far distant date.

For when we walk out together in these mellow seasons of our lives I find her step as brisk, her form as wholesome, and her face as fresh and cheering as on the day we dodged the rice and wore our wedding togs so proudly.

I've never been much of a poetry fan, but one little thing from Tennyson's Idylls of the Kings seems to sum up all successful marriage partnerships. The lines are: "In love, if love be *love,* if love be *ours,* faith and unfaith can ne'er be equal powers." To me it means that two folks who have mutual trust and live on the square are not bothered by triangles.

HOWEVER, WE must be tolerant. Neither of us has had any psychological irritations to frustrate us, and so perhaps we are not capable of testifying in the modern version of skepticism. All we know is that the vaccination "took," and that we escaped the dangers it was meant to forestall—and lived happily ever after, thus far at least.

This reminds me of a friend who in his sixth decade and after thirty-five years of wedded life cut loose and had himself a divorce. "Rather late in life, isn't it, after raising a small family," he said. "But she was not a good companion. She couldn't talk my language or reach the level of my reasoning. I stood it until the kids were gone and then I started fresh alone. In fact, I enjoy it, going where I please and seeking congenial conversation. I am bored no longer and she is probably happier too."

I have no answer, but perhaps if he had been less astute and less profound and a bit more folksy and ordinary-minded, like my frau and I, his heart might have given his brain a better deal. The best time to discover such things is before, not after, a wedding. Of course, the fly in the ointment there is that sometimes people change—alter their ego under pressure of domestic responsibility and put sense ahead of sentiment and self above everything else.

My fault, as She knows too well, lies in super-sentiment and a grave lack of aggressive go-getting, which to some other brands of feminine character would have been ample grounds for a rumpus. That I have escaped divorce is due to her forbearance rather than to much improvement in myself. It's

a mighty good thing I realize this without being told, as it has given me the dash of humility one needs to compromise in tight connubial situations. To know and to accept a partner's limitations, and be thankful it isn't anything really "catching," is half the battle.

Respect on both sides is the rock on which a couple builds a real lasting partnership. I've learned that respect

is strengthened most in times of stress and in the intervals when either partner is obliged to manage the family affairs and household duties alone.

My journeys away from home have been more frequent and lasting than those of my wife, which is a common experience to many couples in these days of activities extended beyond the confines of the local community.

During all my long enforced absences the humdrum functions so vital to the pursuit of happiness and the attainment of security and health were carried on with regularity and dispatch. All pending bills were paid on time, insurance receipts were checked and honored, emergency repairs were attended to, the furnace was kept burning and all rooms warm, a small boy was hired to shovel snow outside, meals went forward on schedule, the kids were neatly clothed and prepared for school, and in summertime the garden and the lawn received such care as a busy household boss could ordain between other duties.

The only thing that seemed to languish a trifle in such periods of my absence was the social exchange. As a rule the neighborhood and lodge and church entertainments and the club dances were designed for man and wife, so that either one of us trying to represent the family alone presented a lone, lorn picture. School affairs like parent-teacher programs were an exception. Here either one of us might attend singly and not feel out of step.

Many a time in my absence the wife was utterly unable to accept a social dinner date with full certainty of meeting our promise. "If he gets home by Friday night, why yes,—but if he doesn't get in before six o'clock and have time enough to clean up, I'll let you know." To a hostess, any such half-hearted acceptance is worse than none. To a wife obliged to make such desperate dates, the experience is trying.

Yet when Yours Truly, the frequent traveler, was left alone to run the household, how vastly different were the results. Nobody ever phoned me for social dinner parties, of course, because most of the women friends of my wife kept tab on her whereabouts and knew when she was gone. No, it was not the invited affairs that bothered me—it was the meals I had to plan and supply right at home.

I SURMISED that if I set the alarm clock properly for a quick morning uprising all would be well. Naturally it did suffice to jerk me out of customary late morning slumber, but the fact that I was fully awake with my pants on was no guarantee that the rest of the day would prove a successful and orderly round of "wifely" duties.

Although careful directions had been dinned at me and even written on tablets left in conspicuous places, the ordinary routine chores of supervising children, pets, and plants, as well as keeping things dusted and clean, answering phone calls, paying bills and shooing away Fuller Brush men, replenishing the larder, attending the furnace and sorting the laundry stocks—these were terrifying tasks for a blundering husband.

I am aware that there are often exceptions. I know that men have told

(*Turn to page* 49)

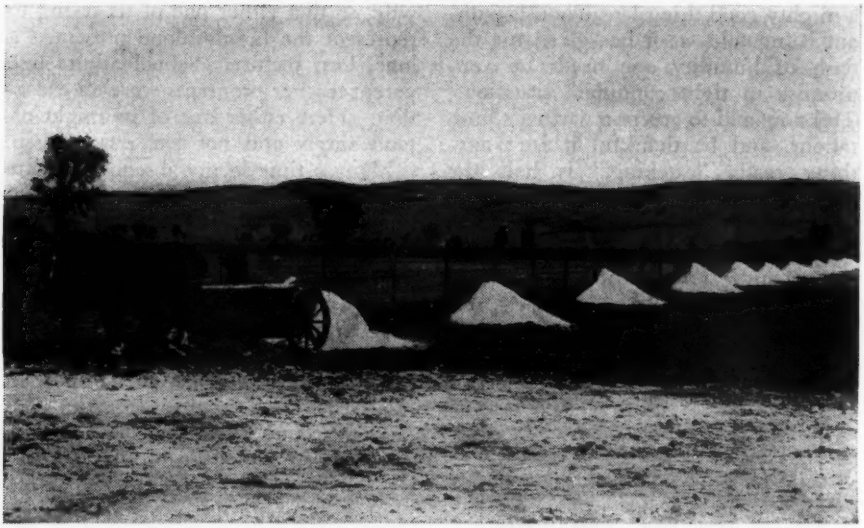

Fig. 1. The 13,000,000 tons of lime applied to Wisconsin's acid soil during the past 11 years have played a major role in the soil and crop improvement program. The acreage of alfalfa has reached the million mark. But there are still 6,500,000 acres of cropland in Wisconsin and another 3,500,000 acres of non-wooded permanent pasture that need lime, calling for a total of nearly 25,000,000 tons to complete the "once-over" job.

Whole-farm Demonstrations

By C. J. Chapman

Soils Department, University of Wisconsin, Madison, Wisconsin

THE primary function of the agricultural experiment station, with its wide and almost limitless array of research projects in laboratory and field, is to discover, try out, and finally apply new ideas and theories in the field of farm science. It is a job of the extension specialist to take the practical and workable findings of research to the farmer and get him to put these new findings into practice. We teach, preach, write, and finally wind up by setting up actual demonstrations on farms in those counties where these new and approved practices are thought to be workable and practical. The widespread adoption by farmers of better soil and crop management practices is the ultimate goal of extension agronomists. And believe me this is a tremendous task, a never-ending challenge.

I have been at it for more than thirty years and in terms of accomplishments and the achievement of goals in Wisconsin, I think I can say our efforts have been fairly fruitful. I have seen the tonnage of fertilizers used in the State

grow from some 3,000 tons back in the year 1916 to the present annual use of over 300,000 tons. I have seen the tonnage of lime increase from practically nothing to a yearly average of nearly 2,000,000 tons. In the wake of these hundreds of thousands of tons of lime and fertilizers, I have seen a great improvement in crop production. I have witnessed a doubling and trebling of our acreage of alfalfa. Clover has become a more dependable and abundant crop on Wisconsin farms. But I would not imply that the job is finished by any means. Wisconsin farmers are still way short of balancing their soil fertility budget; in fact, we are still cashing in on the native resources of our soils.

The fertilizer industry, too, has played an important part in this widespread interest and increased use of fertilizers. They have a product to sell and have spent thousands of dollars in educating farmers toward a more intelligent use of it.

In the spring of 1916 I was hired by Doctor H. J. Wheeler, manager of the Service Bureau of the American Agricultural Chemical Company, to undertake the job of carrying out a program of fertilizer experiments and demonstrations in Wisconsin. I was engaged in this type of educational and exploratory work in the states of Wisconsin, Minnesota, and Ohio for a period of six years, during which time I conducted hundreds of test plots and demonstrations and carried the results of findings and the story of fertilizers to thousands of farmers at meetings held during this period.

At the same time many other fertilizer companies were also doing missionary work in the Midwest. Armour, Swift, and Darling were active and great credit should be given to the work of the Soil Improvement Committee of the National Fertilizer Association, whose staff worked hand in hand with all of us in our early efforts. In more recent years, other educational agencies including the American Potash Institute, the American Cyanamid Company, and the Coke-Oven Ammonia Research Bureau have made substantial contributions not only as educational agencies in their direct appeal to farmers in behalf of a more intelligent and liberal use of fertilizers, but in their

Fig. 2. A "whole-farm" demonstration. Here is Christ Mayer of Junction City (Portage County), Wisconsin, who harvested the first crop of good clover in many years from this field. There are over 400 of these whole-farm demonstrations set up in a five-year cooperative project among TVA, the College of Agriculture, county agricultural agents, and farmers.

support of research fellowships set up at the various experiment stations over the country. The direct support by these agencies through the liberal contribution of fertilizers used in the thousands of test demonstrations carried out in Wisconsin has made possible a tremendous expansion of our test-demonstration program.

Federal Agencies

It has been my privilege to have had a part in this great program. For the past 25 years as a specialist in soils at the University of Wisconsin I have been preaching and teaching the principles of soil fertility maintenance and crop management. I have talked lime, lime, lime for alfalfa, for better and bigger crops of clover, corn, and grain. Our lime production program which tied in with the Federal action agencies, CWA, FERA, and WPA set up on a county- and state-wide basis and carried on for a period of some eight years in cooperation with county agents and their agricultural committees, resulted in a tremendous output of agricultural lime. In more recent years, the AAA (now known as the Production and Marketing Association) has contributed toward the cost of millions of tons of lime used by farmers in this and other states.

The Federal action agencies including the Soil Conservation Service, the Farm Security Administration, and the AAA have also played an important part in the sweeping changes which have taken place in the past few years in the thinking and attitude of Wisconsin farmers toward soil fertility maintenance and soil conservation through the use of commercial fertilizers. During the past 10 years we have carried out a number of large-scale educational drives and programs through our agricultural extension organization.

A state-wide program of soil testing was set up as a project in cooperation with the WPA several years ago. We established some 50 county soil-testing laboratories where thousands and thousands of soil samples were tested. The results of these tests placed in the hands of farmers had the effect of quickening and awakening their interest in fertilizers and lime, and provided an intelligent basis for their purchase and use.

I am convinced that thousands of field demonstrations with fertilizers carried out by county agents in cooperation with our soils extension service and supported by the Middle West Soil Improvement Committee and the American Potash Institute have been an important factor in influencing farmers. The farm machinery manufacturers have supported us in our demonstrational work by loaning us a large number of fertilizer-grain drills and other equipment for the application of fertilizers. During the past five years we have conducted hundreds of "plow-sole" fertilizer demonstrations in Wisconsin. The results of these demonstrations have been tabulated and summarized each year and reports have been placed in the hands of our educational leaders, fertilizer salesmen, and farmers. Stories have been written and published in the farm press in which the results of our demonstrations have been brought to the attention of a high percentage of the farmers in this State.

Whole-farm Demonstrations

Another agency which in the past seven years has played an important role in carrying the story of soil conservation, soil fertility maintenance, and crop improvement practices to Wisconsin farmers has been the Tennessee Valley Authority. "Whole-farm" demonstrations were set up in cooperation with TVA back in 1940.

This idea of whole-farm demonstration was suggested to the writer by the late Professor A. R. Whitson some 20 years ago. Professor Whitson felt that a number of farm-scale demonstrations should be carried on as a follow-up type of project in connection with our State Soils Laboratory Farm Examination Service.

When the Tennessee Valley Authority in 1936 asked us to submit plans in which rather extensive demonstrations

Fig. 3. Yields of corn were increased from 59.9 to 104.7 bushels per acre on the plot receiving 800 pounds of 8-8-8 on the plow-sole. Both plots received the conventional 125 pounds of 2-12-6 in the hill with attachment on the planter. This demonstration, conducted on the Harold Neis farm at Lancaster, Wisconsin, is one of the hundreds of such tests where the "plow-sole" method of fertilizer application has been tried out on Wisconsin farms in the past five years.

might be carried out with the various types of phosphate fertilizers which the Authority was manufacturing, the writer submitted a detailed plan for setting up a number of these so-called "whole-farm" demonstrations. In the proposal it was suggested that a program of soil and crop management be carried out over a period of five years on a selected number of farms where detailed examinations through the medium of the State Soils Laboratory had previously been made.

My proposal in 1936 to the Tennessee Valley Authority for the setting up of these whole-farm test demonstrations was turned down. However, projects of a similar character were inaugurated in the neighboring states of Iowa, Minnesota, and Missouri in the years of 1937 and 1938. During the winter of 1939 and 1940 the writer again worked out detailed plans for the setting up of a Wisconsin project of whole-farm demonstrations in cooperation with TVA and this time we modeled our procedure after the pattern followed by the states of Missouri and Iowa. Agreements between the Extension Service of the Wisconsin College of Agriculture and the Tennessee Valley Authority were drawn up and formally executed. Agreements between the Extension Service of the College of Agriculture, the county agricultural agents, the agricultural committees of respective counties, and individual farmer cooperators were drafted and signed by respective parties. Interdepartmental questions of administrative responsibility were settled and the program was finally launched. Some 45 farm cooperators were selected in three Wisconsin counties as a start in 1940.

The program was expanded in 1941 with nine additional counties coming into the project. At present, we are operating in 33 counties with a total of more than 400 farmers cooperating. An over-all state supervisor employed jointly by the Tennessee Valley Authority and the Extension Service of the College of Agriculture was appointed in 1941. For the past five years this man, Forrest Turner, has done a splendid job in the coordination and supervision of this work.

The value of these whole-farm test

demonstrations as a medium of extension education has been tremendous. The transformation that has taken place on many of the farms in the program has been recorded in almost unbelievable accomplishments. Crop production on many of these farms has been more than doubled. From timothy and quack grass to abundant crops of clover and alfalfa that fill haymows to capacity! Corn cribs and granaries filled to overflowing! New additions on the barns, remodeled and new farm homes! New furniture and household conveniences! And added income that is making possible opportunities for advanced education for the boys and girls in these farm homes!

All of these improvements and new opportunities came out of the same old farm, the same old fields. The same farmers and their families are working these farms. Lime and the liberal application of phosphate and potash fertilizer have literally worked miracles.

The Tennessee Valley Authority in its broad approach to the problems of soil conservation and the regeneration and rebuilding of the farms in this country has centered its great program around the well-established concept that the depletion of the available reserves of phosphorus in our soils was more responsible for crop failures and declining yields than any other single factor. We all recognize the tremendous toll which erosion has taken in a century and a half of careless farming. But by and large, the world over, the exhaustion of soil phosphorus is the number one basic cause of low yields and poor quality in our crops. True, soil acidity and the lack of available calcium and potassium have been partly responsible for the declining productiveness of our soils. In the wake of the combined lack of these major minerals and certain other minor trace elements, clover and other legumes ceased to flourish and in turn we were faced with a state of nitrogen starvation in our pastures and cultivated fields.

Available Potassium Supply Becoming Short

For years in Wisconsin prior to the setting up of our whole-farm demon-

(*Turn to page* 48)

Fig. 4. This photo, taken back in 1917, shows one of several hundred test plots on potatoes. In these test plots some six or eight different fertilizer ratios and combinations of N-P-K were used. Invariably, the complete mixture with potash gave the largest yield. The 4-10-4 plot, left, yielded 354 bushels per acre as compared to the check plot which yielded only 216 bushels per acre. These plots were on the farm of R. H. Clark, Tomahawk, Wisconsin.

Fig. 1. J. W. Nelson, farmer in the Dugdemona Soil Conservation District near Ruston, La., says this improved hop, Persian, and white clover is worth $12 an acre to him in his dairying operation. In building the pasture, Nelson applied a ton of lime, 200 pounds of 20 per cent superphosphate, and 100 pounds of 50 per cent muriate of potash per acre.

Analyzing the Soils of Northwest Louisiana

By Lester L. Loftin

Soil Conservation Service, Shreveport, Louisiana

AT THE REQUEST of soil conservation district cooperators for information on the mineral deficiencies of their farms, in 1944 Soil Conservation Service technicians in Louisiana started taking soil samples and sending them to the State Experiment Station soils laboratory for analyses and fertilizer recommendations. So far, more than 600 samples have been taken in the four soil conservation districts of northwest Louisiana. These include samples of practically all the soils of both the basic land resource areas—Forested Coastal Plain and Red River Bottomland—that make up the four districts.

These analyses reveal that the amount of erosion the land has suffered, the crops that were grown, and the amount and kind of fertilizer that was used directly influence the amount of nutrients available in a soil for plants to use. They reveal also that most farmers living on hill land of the Forested Coastal Plain don't use enough fertilizer to meet the nutrient requirement of plants for proper growth. They show, in ad-

dition, that some farmers in the Red River Bottomland use fertilizers they don't need for crop production while others fail to use a necessary fertilizer.

The soils of the Forested Coastal Plain hills generally are deficient in phosphorus, potassium, and calcium. The average amount of available phosphorus and potassium is about half enough for proper plant growth. Where the available calcium—lime—is too low, as happened in many cases, plants can't gather enough of it from the soil to transmit it to animals. Bone structure suffers. The Forested Coastal Plain soils in this section are slightly to moderately acid. Many of these soils are in the acidity range that is most desired for general field crops.

The laboratory's average fertilizer recommendations for the hill soils of the Forested Coastal Plain with the fertilizer analysis are:

Cotton: 400 pounds of 4-8-8 fertilizer, side-dressed with 100 pounds of nitrate of soda or equivalent an acre.

Corn: 300 pounds of 4-8-8, side-dressed with 200 pounds of nitrate of soda or equivalent an acre.

Oats: 300 pounds of 4-8-8, top-dressed with 200 pounds of nitrate of soda or equivalent an acre.

Clover-grass pasture: None to 4,000 pounds of limestone, 400 to 500 pounds of 20 per cent superphosphate, 100 pounds of 50 per cent potash or equivalent an acre.

Lespedeza-grass pasture: None to 2,000 pounds of limestone, 400 to 500 pounds of 20 per cent superphosphate, 100 pounds of 50 per cent potash or equivalent an acre.

It is estimated that the annual plant-food requirement that should be met through the application of fertilizer in the State of Louisiana is 30,000 tons of nitrogen, 50,000 tons of phosphoric acid, and 40,000 tons of potash. But in the year ended August 31, 1945, only 17,200 tons of nitrogen, 11,000 tons of phosphoric acid, and 6,000 tons of potash were used. The need is for twice as much nitrogen, five times as much phosphoric acid, and seven times as much potash.

The Red River Bottomland soils, according to the analyses, run exceptionally high in available phosphorus and calcium; nevertheless, many river farmers use phosphate fertilizer and occasionally lime on their soils. The only river soils deficient in phosphorus are those that have been influenced by some stream coming into the river bottom from the Forested Coastal Plain area. The samples show that practically all the river soils are deficient in potash; however, very few farmers are using potash even though they are growing considerable alfalfa, a heavy user of that fertilizer. About the only samples showing sufficient potassium were taken on newly cleared land or from old house sites.

The average fertilizer recommendations for the river bottomland soils are:

Cotton: 75 pounds of 50 per cent muriate of potash, side-dressed with 200 pounds of nitrate of soda or equivalent an acre.

(*Turn to page* 40)

Fig. 2. The Soils Laboratory at Louisiana State University took samples which proved this farm of Dan Logan's in the Upper West Red River Soil Conservation District close to Shreveport needed soil amendments. Mr. Logan, shown here in a field of hybrid corn, put out 300 pounds of 6-8-8 fertilizer per acre before planting the crop. Later he side-dressed with 400 pounds of nitrate of soda per acre. In spite of an exceedingly wet year in 1946, Logan harvested 60 bushels of corn per acre.

Minor Plant Nutrients[1]

By H. P. Cooper

Dean and Director, Clemson Agricultural College, Clemson, South Carolina

(Reprinted from Commercial Fertilizer, *January 1947)*

IT is now generally accepted that a large number of elements may be effective in the nutrition of plants. The nutrients are sometimes classed as major nutrients, including the three primary and the secondary, and minor nutrients, depending upon the significance of the various nutrients utilized by plants grown under different conditions.

In the manufacture of the fertilizers containing the three primary nutrients, nitrogen, phosphorus, and potassium, considerable quantities of the secondary relatively strong nutrient ions such as sodium, calcium, chlorine, and sulphur may be added as constituents of certain fertilizer materials. These secondary nutrients may play a very important role in the nutrition of some plants under certain conditions.

Relation of Relative Strength of Ions to the Intensity of Absorption of Certain Nutrients

In considering the major and minor plant nutrients, it may be desirable to note the relationship between the relative strength of ions and the selective absorption of the stronger ions by most plants. Since plants tend to absorb selectively nutrient ions according to relative strength rather than concentration, it is possible to predict the probable relative quantity of ions of different strengths which may be absorbed by many plants. Where comparable concentrations of nutrients are present in the medium, the expected average quantity of materials in a large number of plants would be in agreement with the relative strength of ions. Certain plants which tend to accumulate relatively large quantities of certain nutrients and the partial exclusion of some nutrients by some plants or tissues may be considered as an exception to this generalization. The arrangement of plant nutrient elements in order of relative strength of their ions from the strongest cation material to some of the stronger anion materials are included in Table 1.

Use of Energy Properties of Nutrient Ions in Soil Fertility and Nutrition Studies

The principal difference between inorganic and organic matter is the stored potential energy in the organic compounds. In order to secure a better understanding of the principles involved in plant nutrition, it is highly desirable that consideration be given to the energy properties of nutrient ions utilized by plants. The normal electrode potential, which is a measure of the intensity factor of energy of ions, is one of the most significant properties of nutrient ions to consider in studying the nutrition of plants and animals. The sign of the potential is opposite the pole sign.

Data in Table 1 represent averages for a large number of chemical analyses of different food-plants grown under varying conditions. This type of information may not be applicable to many specific situations, but it will serve to illustrate some of the most common nutrients utilized by many plants. It is noted that there is a close correlation between the relative strength of ions and the probable intensity of absorption and utilization of the various

[1] Technical Contribution No. 141, South Carolina Agricultural Experiment Station, Clemson, S. C.

nutrients by plants. It is generally accepted that there is little relation between the concentration of nutrient ions in the soil colloidal complexes and the absorption of the different ions. The relative strength of ions seems largely to determine the intensity of the absorption of most nutrient ions. There is less of the stronger sodium ion utilized by plants than the weaker calcium ion. This is probably due to the relatively low concentration of sodium ions in many of the soils in humid climates where the concentration of calcium is much higher than sodium. The relatively high content of iron in the plants in relation to strength of ions may be related to the relatively large quantity of iron in most soils. The technique followed in iron determinations may show more iron than is utilized as a nutrient. Much of the iron reported may be due to iron adhering to the surface of plant tissue, iron from mill used in grinding plant materials, or iron as impurities in chemicals used in making determinations. The major plant nutrients are expressed as per cent or parts per hundred; whereas, the minor nutrients are often expressed as parts per million. The three primary constituents of commercial fertilizer are nitrogen, phosphorus, and potassium. These three nutrient materials form some of the strongest ions utilized by plants. The secondary nutrients included in many of the mixed fertilizers are sodium, calcium, magnesium, and chlorine.

In mixed fertilizers the quantities of nitrogen, phosphorus, and potash are guaranteed, but there is usually no guarantee of the quantities of sodium, calcium, chlorine, or sulphur, which also form strong ions and may be absorbed in relatively large quantities, and may have a major role in the nutrition of plants under certain conditions.

The four latter materials may or may not constitute a significant proportion of the mixed fertilizer, depending upon

TABLE 1

THE ARRANGEMENT OF METALLIC NUTRIENT ELEMENTS IN ORDER OF ELECTRODE POTENTIALS OR THE ORDER OF THE RELATIVE STRENGTH OF THEIR IONS FROM THE STRONGER CATION MATERIAL TO THE STRONGER ANION MATERIALS. THE MAJOR NUTRIENTS ARE EXPRESSED AS PER CENT OF DRY MATTER AND MINOR NUTRIENTS EXPRESSED AS PARTS PER MILLION.

Arrangement of Nutrients in Order of Strength of Ions		Average Chemical Composition of a Large Number of Plants
Materials	Normal Electrode Potentials in Volts	
Potassium*	+2.93	2.14 per cent or parts per hundred
Sodium[2]	+2.70	0.70 per cent or parts per hundred
Calcium[2]	+2.50	0.88 per cent or parts per hundred
Magnesium[2]	+1.55	0.31 per cent or parts per hundred
Manganese	+1.09	101 parts per million
Zinc	+0.76	41 parts per million
Iron	+0.43	251 parts per million
Copper	−0.40	11 parts per million
Boron		39 parts per million
Sulphur[2]		0.30 per cent or parts per hundred
Phosphorus*		0.34 per cent or parts per hundred
Chlorine[2]		0.70 per cent or parts per hundred
Nitrogen*		2.63 per cent or parts per hundred

*Primary fertilizer nutrients.

[2] Secondary fertilizer nutrients.

the material from which the mixed fertilizer is made. Where such materials as mono- and dicalcium phosphate, ammonium sulphate, sodium nitrate, and muriate and sulphate of potash are used, sufficient quantities of these elements may be included in the fertilizer to supply the annual requirements of the crop being fertilized. However, where such concentrated materials as ammonium nitrate, ammonium phosphate, potassium phosphate, and urea are used in formulating high analysis grades of fertilizer, including 30 to 50 per cent or higher plant-food content, such nutrients as calcium, magnesium, sulphur, and chlorine may be deficient and become limiting factors in the production of crops. In many cases the calcium and magnesium requirements are being met by the application of limestone to the soil or through the inclusion of dolomitic limestone in the production of non-acid-forming fertilizers.

Soil Conditions Influencing Availability of Minor Plant Nutrients

The minor metallic nutrients such as manganese, zinc, iron, and copper and other minor non-metallic nutrients such as boron are not generally included in mixed fertilizers. Until recently little direct effort has been made to determine the conditions influencing the availability of minor nutrients in different soils. Alkali, over-limed, and strongly acid soils are likely to be deficient in certain minor plant nutrients. On many of the strongly acid, highly leached soils the minor plant nutrients are often the limiting factor determining the yield of crops. It is, therefore, becoming increasingly important that greater attention be given to the need for various minor nutrients on the different soils and to the quantity and form to apply under the varying soil conditions for certain crops.

On soils with a relatively high pH value or high in limestone there is often an accumulation of insoluble compounds of metallic elements forming

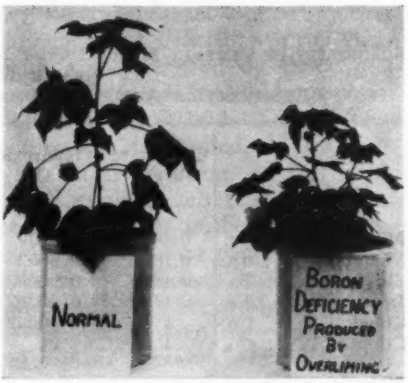

Fig. 1. The cotton plant on the left is normal, but the plant on the right shows boron deficiency. Note the low plant, short internodes, and profuse branching. Most of the fruit buds abort and few mature bolls are formed. (Grady sandy loam)

relatively weak ions such as manganese and iron. The accumulation of such materials is related to the relatively low solubility of the carbonates, hydroxides, or oxides of these elements; whereas, there is a loss through leaching of soluble compounds on strongly acid soils with a relatively high content of sulphate, chloride, or nitrate ions. The solubility value of the different minor nutrients is included in Table 2. Any cultural treatment resulting in a large change in the pH value of a strongly acid, highly leached soil may significantly change the solubility and availability of most of the metallic minor nutrients.

The increased use of lime on our soils and the resulting higher crop yields requiring a larger supply of nutrients, and the direct effect of additions of limestone to the soil on decreasing the solubility and availability of the minor nutrients will call for a program to supply minor plant nutrients to our soil or directly to the plants as in sprays.

As the minor plant nutrients including such materials as boron, manganese, zinc, iron, cobalt, and copper may be deficient elements in the growth of certain crops under some conditions, it is desirable to consider the solubility of certain nutrient salts. Relatively large

TABLE 2

SOLUBILITY OF CERTAIN MINOR PLANT NUTRIENTS IN GRAMS OF ANHYDRIDE PER 100 GRAMS OF COLD WATER
TEMPERATURE AROUND 20 DEGREES CENTIGRADE OR AS INDICATED.

Ion	Carbonate CO_3	Hydroxide OH	Phosphate PO_4	Sulphate SO_4	Chloride Cl	Nitrate NO_3
Magnesium....Mg	0.0106	0.0009	0.0205	26.0°	35.3	42.33
Manganese....Mn	0.0065	0.0002	sl. s.	52.0	62.2	426.4°
Zinc.....Zn	0.001	0.00000026	i	86.5°	432.0	327.3[10]
Iron.....Fe	0.0067	0.00067	i	15.65	64.4	83.5
Cobalt.....Co	i	0.00032	i	36.2	45.0[7]	133.8°
Copper.....Cu	i	i	i	14.3°	70.6°	137.8°

quantities of some of the minor plant nutrients such as boron, manganese, and iron may be toxic if excessive amounts are soluble in the soil. The solubility and the availability of these elements are determined largely by the soil reaction. Under most conditions nutrients reach an equilibrium and the soil complexes are favorable for the dominance of certain types of plants. Fertilizer and liming treatments may significantly modify the solubility and the availability of the various nutrients to certain plants.

Solubility of Minor Nutrient Compounds

Since the minor plant nutrient elements are most likely to be deficient in alkali, alkaline, over-limed, and strongly acid soils, it is desirable to consider the solubility of minor nutrient compounds. The lack of solubility and availability of the metallic minor nutrients in the presence of larger quantities of the stronger metallic ions in the soil solution may be the limiting factor in crop production on many soils. The deficiency of the total quantity of metallic minor nutrients in strongly acid soils is usually due to the solubility and leaching from the soil of the limited quantity of the minor nutrients which accumulate in strongly acid soils. The data in Table 2 showing the solubility values are very helpful in predicting the availability of the different metallic minor nutrients in the soils of various origin. The data on solubility values indicate the reason for relating the availability of metallic minor nutrients with the pH of the soil, applications of limestone, phosphorus, sulphate, chloride, and nitrate. The addition of limestone to the soils increases the carbonate and hydroxide content of the soil and may significantly decrease the solubility and availability of certain of the minor nutrients to plants. The addition of large amounts of phosphorus to the soil may markedly reduce the solubility and availability of such nutrients as zinc, iron, cobalt, or copper; whereas, the additions of large quantities of sulphate, chloride, or nitrate may markedly increase the solubility and availability of these nutrients.

These solubility values are very useful in predicting the soil conditions determining the desirability of adding minor nutrients in commercial fertilizers. The more general use of limestone on Southern soils has resulted in a critical deficiency of minor nutrients in many situations. The availability of the minor nutrient most widely affected by liming in this area is boron. There is a widespread deficiency of boron on soils heavily limed for the production of such legume crops as alfalfa. In addition to legume crops, the root and tuber crops such as beets, turnips, carrots, and potatoes may show a marked yield response to additions of boron.

The relatively low intensity of absorp-

tion and the relatively low mobility of the minor nutrients in tree plants suggest the necessity and desirability of applying some of the minor nutrients such as zinc, iron, and cobalt, which form insoluble compounds as hydroxides, carbonates, and phosphates in the soil, in spray solutions to foliage for best results. The very low solubility of zinc hydroxide suggests one of the reasons for the low availability of zinc in alkaline soils or soils with a relatively high pH value and a high concentration of hydroxyl ions.

Boron Deficiency

The boron content of soils varies from toxic quantities in arid regions to a marked deficiency as occurs in some of the heavily limed, highly leached soils in the Atlantic Coastal Plain region. The addition of large quantities of limestone to some of the strongly acid soils may result in a marked deficiency of boron.

The cotton plants in Figure 1 show a deficiency of boron induced by overliming. Boron deficiency in the cotton plant is characterized by short internodes and profuse branching of plants. Most of the fruit buds abort and few mature bolls are formed.

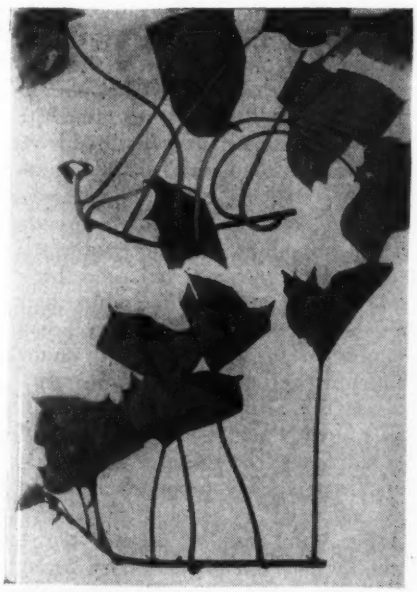

Fig. 2. The sweet potato vine on the bottom is normal while the one at the top is boron deficient. Note the short internodes, curled petioles, and distorted terminal bud on the vine showing boron deficiency.

Dr. C. J. Nusbaum at the Edisto branch of the South Carolina Experiment Station has studied the response of the sweet potato plant to addition of boron in different fertilizer combinations. The picture in Figure 2 shows the contrast between the normal plant and a plant showing boron deficiency. Vine shown at the top of the picture is from a boron-deficient plant, while that at the bottom is from a normal plant. Note the short internodes, curled petioles, and distorted terminal bud on plant showing boron deficiency.

A photograph showing the comparative yield of No. 1 sweet potatoes from three adjacent borax treated plots in a low lime, high potash series is shown in Figure 3. The highest yield was obtained from the application of 5 pounds of borax per acre. The yields of marketable potatoes for no borax, 5, 10, 20, and 30 pounds of borax per acre are 153, 235, 186, 159, and 133 bushels per acre respectively. The details concerning these experimental data are published in the Fifty-Seventh Annual Report of the South Carolina Experiment Station.

Solubility of Boron Compounds

The solubility values for the different boron compounds included in Table 3 suggest the probable effects of additions of lime on the solubility and availability of the boron in the soil. It has been observed that there is a definite quantitative relationship between the symptoms of boron toxicity and deficiency of such metallic cations as potassium and calcium in the nutrient complex. The potassium tetraborate is readily soluble in water and the presence of a large quantity of potassium in the soil will increase the solubility and availability of the boron in the soil. The presence of the available potassium would tend

to increase the absorption and accumulation of boron in plant tissue. Therefore it is logical to expect that high potash fertilization may increase boron toxicity symptoms by lowering the resistance of plants to boron. This would be particularly true where there is in the soil a deficient supply of the relatively strong anions such as nitrate, chloride, or sulphate. Increasing the soluble calcium supply through liming practices may significantly depress the solubility of the boron in the soil through the formation of the relatively insoluble calcium borate. A small intake of calcium may lower the tolerance of the plant for boron, whereas an excessive intake of calcium may result in the plant having a high boron requirement.

Inclusion of Boron in Fertilizers

Since excessive quantities of soluble boron compounds may prove very toxic to certain plants, it is highly desirable to be extremely careful in including large quantities of boron in mixed fertilizers. The optimum quantity of boron for different crops may vary from the equivalent of 5 to 20 pounds of borax per acre depending upon the crop. It is not likely that the inclusion of 10 pounds of borax per ton of fertilizer would be an excessive amount for soils in humid regions where 1,000 pounds or less of fertilizer per acre are applied. Where the fertilizer application is a ton or more per acre, not more than 5 pounds of borax should be included in the fertilizer mixture for most crops. It is usually desirable to add as much as 20 pounds of borax per acre for alfalfa, particularly on soils which have been heavily limed.

Improved soil management practices and increased yields of crops very probably will make it necessary to include boron in the fertilizer for most crops. Many of our legume, root, and tuber crops such as beets, turnips, carrots, and potatoes often show a marked yield response to additions of boron to the fertilizer combination used for the different crops grown under various conditions.

Manganese

Manganese is generally recognized as one of the minor plant nutrients. It is usually widely distributed in minerals and soils and is often in association with iron, magnesium, and calcium.

TABLE 3

SOLUBILITY IN GRAMS OF ANHYDRIDE PER 100 GRAMS OF COLD WATER

Boric acid	H_3BO_3	= 5.15^{21}
Potassium tetraborate	$K_2B_4O_7.5H_2O$	= 26.70^{30}
Sodium tetraborate (borax)	$NaB_4O_7.10H_2O$	= 1.60^{10}
Calcium metaborate	$Ca(BO_2)_2.2H_2O$	= 0.31^{30}

The acidity of the soil seems to be one of the most important factors in influencing the accumulation or the leaching of the manganese from the soil. The data in Table 1 show that manganese carbonate and hydroxide are relatively insoluble and a soil complex with a relatively high pH value will tend to accumulate insoluble manganese compounds. In the Southeastern states the chocolate, red, and brown soils often contain considerable quantities of manganese which may become soluble in toxic quantities if cultural and fertilizer practices significantly increase the acidity of such soils. On soils already acid with large quantities of sulphates, chlorides, or nitrates, soluble manganese compounds are formed as indicated by solubility values in Table 2 and may be leached from the soil in humid climates. The strongly acid gray sandy loam soils such as those found in the Coastal Plain are most likely to be deficient in available man-

(*Turn to page* 44)

Fig. 1. With a push here and a shove there, this bulldozer operator rolls a huge boulder onto a giant, steel stoneboat.

Reshaping New England Farm Land

By A. B. Beaumont

Soil Conservation Service, Amherst, Massachusetts

UP New England way, Mother Earth is undergoing face-lifting operations which are not only improving her appearance but are making her more physically fit to meet the strong agricultural competition that is now upon us. Glacial boulders are being pushed around by the thousands, land hummocks leveled, and wet soils drained. While some woods and brush are being cleared from potentially good agricultural land, thousands of trees are being planted on non-agricultural sites. Farm ponds, also, are being constructed in a region naturally well supplied with lakes and ponds. Much of this activity in land improvement is being aided and fostered by soil conservation districts.

The trouble all along has been due to what happened to this landscape during periods of glaciation, some 25,000 to 50,000 years ago—only yesterday in geological time. That glaciation improved the soils of New England, it is generally agreed by pedologists, but every tiller of the soil of this section knows that the land surface was left in far from perfect condition. Farmers from the stone-free prairies of the Midwest are often surprised and dismayed by the numerous boulders of New England farm land. The story is told of a Midwestern farmer visiting this section for the first time. On asking a New England farmer where all the boulders came from, he was told that the glacier brought them. "Well, where is the

glacier now?" "Gone back to get more boulders," was the reply. Maybe he was right.

Ten generations of New England farmers have removed many of the field stones. Most of these stones went into stone walls, partly because that was one way to get rid of them and partly because enclosures were needed. Most stone walls of this section antedate the invention of barbed wire by 100 to 200 years. The more numerous the stones, the more frequent were the walls, and the smaller the fields. Many fields or "lots" are two to five acres in area. Such small fields were all right for the period of the ox team and the hand scythe, but are an anachronism in this time of tractors, mowing machines, and pick-up hay balers.

In the old days, it was common practice for the farmer, his sons, and the hired man to "pitch in" after the harvests to "make" an acre or two of land and build a few rods of stone wall—a never-ending, back-breaking task. Nathaniel Shaler, famous geologist, estimated that by the last turn of the century as much labor had been expended in the building of stone walls in Massachusetts as had been devoted to building all the roads and all the buildings in the State. We have estimated from a measured sample that there are some 7,500 miles of interior stone walls in Massachusetts, at least two-thirds of which should be removed in the interest of modern farming methods, including the use of power field equipment and the establishment of soil conservation practices.

It is indeed a "far cry" from the simple equipment and low power used by New England farmers of several generations past to the high-powered, complicated, but effective machinery used today for land improvement. Farmers of bygone generations would stand in astonishment at the sight of modern mechanical behemoths now used. Then they had only crowbars, levers, hand shovels, perhaps a home-made capstan, and man-, horse-, or ox-power. Now they have bulldozers of different types, power shovels, draglines, improved stone-boats, and dynamite. I stood in amazement a while ago as I watched a skilled operator with a powerful bulldozer push a 10-ton boulder out of the soil and onto a large steel stone-boat and then hitch to the stone-boat and drag the boulder away.

Fig. 2. Glacial boulders removed from agricultural land by means of a bulldozer.

Fig. 3. A dragline does the "dirty" work in large drainage ditch construction.

It is surprising, though, to see what large boulders were moved and placed in stone walls by farmers of earlier periods. But many stones left by former generations of farmers, because they had no means for moving them, are now being moved easily with modern mechanical giants. Some of the larger boulders, and also rock outcrop, are being broken with dynamite before removal. An old practice with respect to huge boulders was to dig holes close by the side of them and then pry them into the excavations. This was a dangerous practice, sometimes causing injury or death. A similar procedure is sometimes employed now, using a bulldozer or power shovel for digging the hole, and there is practically no danger connected with it.

Unfavorable topography is another New England handicap to modern stream-lined farming methods. While glaciation generally softened and smoothed a rough and jagged preglacial topography, there still remain hills and valleys, knolls and slopes, to which square and rectangular fields are no better fitted than is a square peg to a round hole. Small fields make a bad situation worse. Enlargements of fields by removing stone walls are making it possible to fit the fields to the land rather than attempting the impossible of fitting the land to the fields. It has taken New England farmers a long time to realize the importance of the former and the futility of the latter. Contour-planted rows and strips, sweeping in graceful curves across slopes and around hills, are now appearing on New England farm land, adding charm and beauty to a naturally attractive landscape.

In order that New England farmers may successfully compete with farmers on land more favored by nature, it is increasingly necessary that New England farm land be reshaped for the use of modern farm machinery. This is not a new idea,—farmers of this section have done it more or less since the days when they first began removing boulders. But in recent years the amount and the tempo of such work have been markedly stepped up. In a small way the work of glacial forces of thousands of years ago is being undone, and, oddly, the energy stored in the earth in an earlier geological age, in petroleum, is being largely used for the purpose. Powerful machinery actuated by the internal combustion engine is doing the job instead of the hand labor of generations past.

There is no standard procedure or method in the modern disposal of stones. Each farm is an individual case. Disposal is easy and inexpensive when there is a ravine or swamp nearby, into which the stones may be pushed or hauled on truck or stone-boat. Sometimes, as in the case of a stone wall, a deep trench may be dug with power shovel or bulldozer and the stones buried and covered with at least two feet of soil. Some stones are used to build foundations for farm roads or highways. Sometimes they are simply pushed to the side of a field with no particular consideration for future developments. Such disposal is often unsightly and may later cause trouble. There should be a well-conceived plan for each case of stone removal. Technicians of the Soil Conservation Service

assisting district supervisors are rapidly accumulating a body of knowledge of the best methods and procedures in this type of land improvement.

Farmers are spending up to $150 per acre for stone removal. It is hard to justify some current stone removal on economic grounds, but that was also true in the past. However, in the past practically all the work was done by farm help at odd times, and there was little or no cash outlay. Even with a large cash outlay many farmers justify investing more in the improvement of their own land than comparable improved land at a distance from their farms could be bought for, on the basis that they already have a certain overhead in buildings and equipment and that the nearby land helps make a more efficient operating unit. But some farmers, particularly wealthy industrialists to whom farming is a sideline, are investing more money in land improvement than appears justifiable from an economic standpoint.

According to records taken by C. R. Creek of the Massachusetts Experiment Station, it cost $45 to $135 per acre to remove boulders from a rough pasture with a bulldozer, as a first step in land improvement. An additional $10 per acre were spent in picking up smaller stones in preparation for seeding. Scattered stones were pushed off hay, corn, and vegetable land at costs ranging from $20 to $85 per acre. All this work was done with privately contracted equipment. In Vermont, where equipment is operated by soil conservation districts, costs of similar work have been reported somewhat lower than those above.

Mr. Creek has reported costs of stone wall removal at 85 cents to $1.10 per linear yard, where a trench was dug with a gas shovel and stones were pushed into it with a bulldozer. Somewhat lower costs have been reported in Rhode Island when the stones of a wall were pushed onto a giant steel stone-boat and hauled to a nearby swampy area for disposal. The steel stone-boat in this case was designed by technicians of the Soil Conservation Service and can carry a load of 10 to 15 tons of stone. It can be used for transporting large field boulders as well as the smaller stones of walls. Stone walls are also removed by loading them into trucks with a power shovel and then

(*Turn to page* 39)

Fig. 4. Terraced and contoured tobacco in the Connecticut Valley.

Fig. 1. A common sight in Aroostook County potato fields at time of blossoming. A favorable combination of weather, soil, and adequate fertilization results in luxuriant growth of vines and high yields of tubers.

Fertilizing Potatoes Economically in Aroostook County, Maine

By G. L. Terman and Arthur Hawkins[1]

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MAINE currently produces more potatoes than any other state in the United States. Of the total output in Maine, Aroostook County produces about 85 per cent. In addition to high total production, the average acre yield of potatoes for Aroostook County is higher than that for any state. The reasons for this high acre yield and high total production include a combination of favorable conditions for growing potatoes, such as cool temperatures, sufficient precipitation for good crops in most years, suitable soils, the use of good seed, and adequate fertilization. During the war period prices have been favorable and most potato farmers have been "pouring on" the fertilizer. It is their opinion that, since fertilizer costs make up only a small portion of the total production costs, there is no point in taking a chance that fertilizer will be the limiting factor in determining the yield per acre.

It was estimated from a study made in Aroostook County in 1940 and 1941 that the average fertilizer application for each crop of potatoes grown was approximately equal in plant-food con-

[1] Agronomist, Maine Agricultural Experiment Station, and Associate Soil Scientist, Division of Soils, Fertilizer, and Irrigation, U.S.D.A., respectively.

tent to 2,000 pounds of a 5-9-11 fertilizer per acre. This is, of course, a much higher rate than is normally applied for potatoes in most other areas, with the exception of certain states farther south along the Atlantic and Gulf Coasts.

The question of what effect the high rates of fertilizer application have had on the soil and the perhaps more practical question of whether the rates and analyses of fertilizer used are the most economical ones might be raised. During periods of high net returns this latter question might not be too important. With the prospect in the near future of the necessity of lowering production costs, however, the question assumes more important proportions.

Soil Fertility Survey of Potato Soils

In an attempt to obtain some of the answers, a coordinated attack was made upon the problem by the Maine Agricultural Experiment Station in cooperation with the Bureau of Plant Industry of the U. S. Department of Agriculture. This study was part of a regional study of potato soils [2] conducted by the various states along the Atlantic and Gulf Coasts and the Division of Soils, Fertilizers, and Irrigation of the Bureau. As an approach to the problem in Maine, a soil fertility survey of three potato-producing areas in Aroostook County was made in 1944. The areas surveyed were the central Aroostook area, Fort Kent in the northern part, and the Sherman area in the southern part of the County. At the time soil samples were taken, there was obtained from the farmer an estimate of the number of times his land had been cropped to potatoes during the past 10- or 20-year period and the amount of fertilizer that had been applied to the land in those periods. The amounts estimated were in fairly close agreement with the rates of application found in the study made in 1940 and 1941. The samples of soil taken were analyzed for acidity, organic matter, readily soluble phosphorus, exchangeable potassium, and other exchangeable bases.

TABLE 1. ESTIMATED AVERAGE AMOUNT OF PLANT NUTRIENTS APPLIED IN FERTILIZERS PER ACRE FOR POTATOES IN AROOSTOOK COUNTY, THE AMOUNT REMOVED IN A 400-BUSHEL CROP OF TUBERS, AND THAT LEFT IN THE SOIL.

Plant nutrient	Applied for the crop lbs.	Removed in tubers lbs.	Left in the soil	
			Lbs.	%
Nitrogen (N).....	100	80	20	20
Phosphorus (P_2O_5)....	185	20	165	89
Potassium (K_2O)....	225	130	95	42
Calcium (CaO)....	180	3	177	98
Magnesium (MgO)...	36	10	26	72

It was found from the survey that, as a result of heavy fertilization of potatoes, there had been a very great residual accumulation of certain plant nutrients in the soil, notably phosphorus and potassium. The accumulation of these nutrients was directly related to the amounts applied in the fertilizer for each crop and the frequency of cropping to potatoes. That is, where erosion was not serious and the farmer had cropped his land frequently to potatoes—practically every year, in two years out of three, or one year in two—the content of residual plant food in the soil was much greater than where he had followed a system of cropping the land to potatoes once in three years or less frequently. Very little or no fertilizer is applied to other crops in the rotation in Aroostook County as compared to the amount applied for potatoes.

The accumulation of fertilizer residues may be explained by the difference in the amount of plant food applied in the fertilizer for potatoes and

[2] Proceedings of the Soil Science Society of America 10:240-256. 1945.

Fig. 2. On soils high in residual phosphorus, good growth and high yields of potatoes can be produced with fertilizer containing no phosphorus. Plots fertilized with 2,000 pounds of 5-0-10 per acre in this field test in 1946 yielded 509 bushels per acre, while those fertilized with 2,000 pounds 5-6-10 yielded 575 bushels.

that removed in the tubers. The amount of plant food in the vines is not concerned, since they are left on the land and their content of plant food is largely returned to the soil. As shown in Table 1, only 11 per cent of the phosphorus applied in the fertilizer is removed by a 400-bushel crop of tubers, while 89 per cent is left in the soil. Similarly, 58 per cent of the potassium is removed in the tubers, while 42 per cent is left in the soil. With calcium and magnesium, too, only a small portion of these nutrients added in the fertilizers is removed by potatoes. Besides being added in the fertilizer, calcium and magnesium are also added to the soil in large amounts by liming with ground dolomitic limestone, the liming material most commonly used in Aroostook County.

The amounts of plant nutrients remaining in the soil are the result of several factors. In Table 1 only the amounts removed in the tubers are considered. Removal by other crops in the rotation, soil erosion, and leaching also reduce the portion of the total amount applied which remains in the soil. It is commonly known that relatively small amounts of phosphorus and potassium are leached from the soil in relation to the amounts applied, while relatively large amounts of calcium and magnesium are removed in this manner. This accounts in large part for the lack of any considerable build-up of calcium or magnesium in a well-drained soil under humid conditions.

Residual Plant-food Content of Aroostook Soils

Results from the fertility survey showed soils ranging from 25 to 609 pounds of readily soluble P_2O_5 per acre (expressed as pounds per 2,000,000 pounds of soil, as determined by the Truog method), with about 39 per cent of the samples falling in the range of 101 to 200 pounds, 16 per cent below this amount, 42 per cent in the range of 201 to 450 pounds, and only 3 per cent above 450 pounds. The average content of readily soluble P_2O_5 in uncleared soils of Aroostook County is about 35 pounds per acre. As to the exchangeable (available) potassium content, the soils ranged from 38 to

1,036 pounds K_2O per acre (2,000,000 pounds of soil) with only a few samples falling below 100 pounds. Compare this range with an average content of 70 pounds exchangeable K_2O per acre in virgin soils. From these comparisons it may be seen that practically all of the soils that have been cropped to potatoes, with a few exceptions, are more fertile with respect to content of phosphorus and potassium than are similar soils which have never been cropped.

In following up the findings of the fertility survey, well-replicated fertilizer experiments were located in 1945 and 1946 on soils considered to be low, medium, and high in their content of residual P_2O_5 and K_2O for growing potatoes. Many fertilizer experiments had been conducted prior to 1945, but little attempt had been made to relate the fertility level of the soil to the response of potatoes to fertilization with P_2O_5 and K_2O. For readily soluble phosphorus, the arbitrary divisions made were: low, less than 250 pounds P_2O_5 per acre; medium, 250 to 450 pounds; and high, more than 450 pounds. For exchangeable potassium, the divisions made were: low, less than 300 pounds K_2O per acre; medium, 300 to 500 pounds; and high, more than 500 pounds. All fertilizer mixtures were applied in side-bands with a two-row potato planter with fertilizer attachments specially constructed to insure uniform application. Rows were spaced 34 to 36 inches apart and seed pieces planted nine inches apart in the row.

TABLE 2. RELATIVE RESPONSE OF POTATOES IN 1945 TO P_2O_5 ON SOILS HAVING DIFFERENT LEVELS OF RESIDUAL P_2O_5.

Fertilizer treatment Pounds per acre of N–P_2O_5–K_2O	Relative[1] response to fertilization		
	Soils low in P_2O_5 (Av. 4 tests)	Soils medium in P_2O_5 (Av. 4 tests)	Soils high in P_2O_5 (Av. 3 tests)
100– 0–200	.....	.....	94
100– 40–200	96	91	97
100– 80–200	98	96	100
100–120–200	97	97	98
100–160–200	100	100	100
100–200–200	100	.....	.....

[1] Average yields for 2,000 pounds of 5-8-10 fertilizer taken as 100 are: low soils—383, medium soils—328, and high soils—342 bushels per acre. These differences are due to differences other than soil fertility, such as location, weather, variety, etc.

TABLE 3. RELATIVE RESPONSE OF POTATOES IN 1945 TO K_2O ON SOILS HAVING DIFFERENT LEVELS OF RESIDUAL K_2O.

Fertilizer treatment Pounds per acre of N–P_2O_5–K_2O	Relative[1] response to fertilization		
	Soils low in K_2O (Av. 2 tests)	Soils medium in K_2O (Av. 3 tests)	Soils high in K_2O (Av. 6 tests)
100–160–100	96	97	100
100–160–150	98	99	101
100–160–200	100	100	100
100–160–250	98	98	99
100–160–300	98	100	99

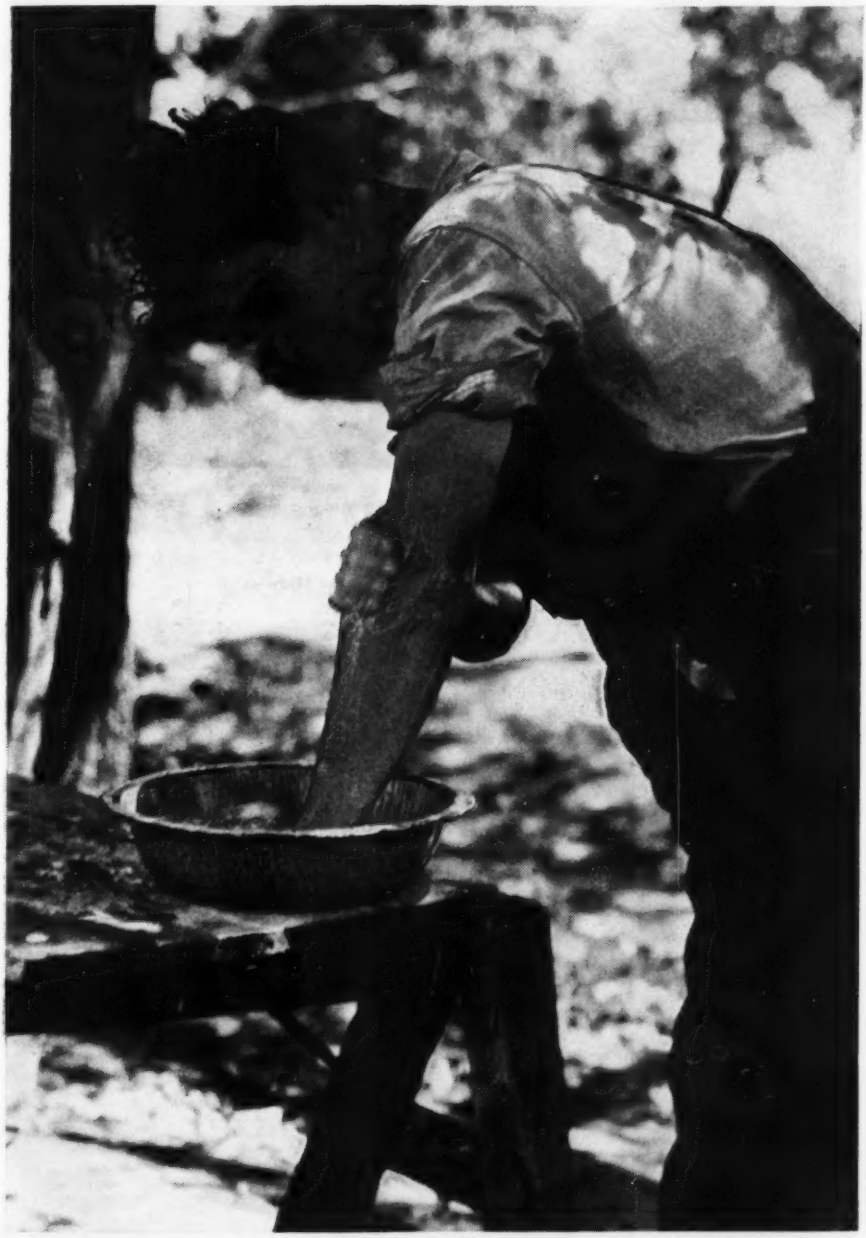
[1] Average yields for 2,000 pounds of 5-8-10 fertilizer as 100 are: low soils—400, medium soils—363, and high soils—308 bushels per acre. These differences are due to differences other than soil fertility, such as location, weather, variety, etc.

Results from Fertilizer Experiments in 1945

In 1945, eleven rate tests of P_2O_5 were completed, as well as eleven of K_2O. In this year two of the tests were located on soils considered to be low in readily soluble P_2O_5, six on soils rated as medium, and three on soils high in P_2O_5. In Table 2 is given the average relative response of potatoes to fertilization with P_2O_5, based on the above grouping. The rather low response to applied P_2O_5 on soils of all levels of available P_2O_5 may be noted. The lack of any appreciable response to P_2O_5 in one of the two tests on soils

(*Turn to page* 41)

PICTORIAL



WASHING UP!

Above: **At work again after the mid-day siesta.**

Below: **Shadows on a by-way in the Midwest.**

Above: **A good thresh is quantity plus quality.**

Below: **Bumper crop left wheat on the ground.**

Hoosier farmers believe in seeing how the other fellows do it. After a picnic dinner at Frankfort, Indiana (above), this Farm Management Tour made a stop at the nearby farm of George Rothenberger (below).

The Editors Talk

Limiting Factors

In our striving for higher yields and greater efficiency of production, new problems which in the past have been given little consideration are being met. It usually has been thought that such factors as sunlight, carbon dioxide, and oxygen were practically limitless so far as crop-producing needs were concerned and should such not be the case, there was nothing that could be done about it. With the recent development of improved varieties of crops, heavy fertilization, and thick crop stand or population in order to gain the maximum production per unit of land, it looks as though these "limitless" factors may become limiting.

Investigations now under way cause one to wonder if sunlight can be a limiting factor when corn or other crops are thickly planted. A way around this has been suggested by interplanting crops of different heights so as to allow light to reach more of the plants and also to permit more circulation of air. Work in several states in the Midwest and South is underway based on the idea that heavy populations of corn on one acre and soybeans on another acre may not give as good results as interplanting the two on two acres. These investigations look very promising although conclusions cannot yet be made.

Other work underway involves means for increasing soil aeration. Lysimeters which formerly were used to measure leaching and water movement are now being used also to study air movement in the soil, and what might be called a forced draft is being employed to force air through the soil in lysimeters to see what effect this added aeration will have on crop growth. This study is interesting in its implications especially in view of the recognition of a soil compaction, resulting over large areas of the humid zone from decreasing organic content of the soil and the use of heavy implements, and limiting root growth of most plants.

This recognition is leading to a new interest in the use of the deep-rooted legumes having the ability to penetrate these compact layers. New tillage implements also are being devised to cope with the problem. The question of oxygen in the root zones of plants as well as that of carbon dioxide as a limiting factor in plant growth which have been touched on only lightly in this country in the past are receiving much more attention as a result of such lines of investigation.

New ways of getting fertilizers into the soil are being undertaken with great potentialities of influence upon fertilizer practices. The use of the direct application of nitrogen solutions to soils opens up a number of lines for investigation. The low cost of such nitrogen applied in the fields may necessitate an exploration of economic factors and result in some of our ideas as to the proper amounts of fertilizer to use and even farming systems being radically changed. The possibilities of overcoming nitrogen deficiencies during the course of a single crop season might influence considerably the possibilities of increasing yields or at least of preventing the lowering of production due to nitrogen deficiencies during the season. Other fertilizers also may be applied in solution and this

combined with the use of portable irrigation may greatly reduce the gamble on the weather always being made by the growers.

Greater recognition of the role of minor elements is having its effect on fertilizer practices. In some areas the so-called minor or secondary elements have now become so widely needed that their use is as common as that of the so-called major elements. Present indications lead one to believe that such a trend will continue and probably spread to most of our agricultural soils. Often being asked is the question as to whether some of the so-called rare elements may not be factors in crop production. Commonly neglected in the past because of lack of sufficient refinement in our research tools, their role in plant nutrition may be brought to light in further research.

Some of our scientists are talking about 300 bushels of corn per acre and seemingly fantastic production of other crops. While yields of this range may not be immediately possible, who can say they will not eventuate when one looks back over the strides that have been made in recent years in meeting our agricultural production goals? When shooting at such yields, however, it is almost certain that many of the factors in plant growth that have been regarded in the past as non-limiting will have to be given due consideration in the future.

Back to School

Although remarkable progress in rural education has been achieved, particularly in the consolidation of schools and club activities, there is still much food for thought in a statement once made by the late J. McKeen Cattell, far-famed educator and supporter of the advancement of science. In an article published in the Popular Science Monthly for January 1909, he wrote:

> "Mankind will last only so long as children are born and cared for; and no plausible substitute for the family has been proposed . . . The school by its nature weakens the family, for it takes the children away from home and gives them interests not centered in the home . . . We need most of all to make life in the country attractive and fine . . . The country school is at present no such place. Its general tendency is not to prepare children for usefulness and happiness in country life, but rather to make them inefficient and uncomfortable there and to send those who are more clever and ambitious away to the city. And the school shares with the city the bad preeminence of being one of the principal causes now working to break up the family . . . Can one not fancy a school in the country, the house a model of simple beauty . . . surrounded by gardens, orchards, and barns? In this house the children would gather . . . for some two hours a day. The master and mistress and their older children . . . would teach the tricks of reading, writing, and reckoning to those who lacked them, and all would be encouraged to go as far as they cared along the paths of letters and science. Two further hours might be spent in working about the place, in the shop, in the garden, or with the animals, sewing, cooking or cleaning, learning to do efficiently and economically the things that must be done . . . Children would always be the chief concern in a home and in a school such as this. There would be no pathological, no economic, no psychological conditions at work for their extermination."

We are hearing much about the systems of Progressive Education in our urban schools. Was Dr. Cattell thinking of one for our rural schools? It was on his great foresight that he gained much of his renown.

Season Average Prices Received by Farmers for Specified Commodities *

Crop Year	Cotton Cents per lb.	Tobacco Cents per lb.	Potatoes Cents per bu.	Sweet Potatoes Cents per bu.	Corn Cents per bu.	Wheat Cents per bu.	Hay Dollars per ton	Cottonseed Dollars per ton	Truck Crops
	Aug.-July	.....	July-June	July-June	Oct.-Sept.	July-June	July-June	July-June	....
Av. Aug. 1909–July 1914	12.4	10.0	69.7	87.8	64.2	88.4	11.87	22.55	....
1922	22.9	22.8	65.9	100.4	74.5	96.6	11.64	30.42	....
1923	28.7	19.0	92.5	120.6	82.5	92.6	13.08	41.23	....
1924	22.9	19.0	68.6	149.6	106.3	124.7	12.66	33.25	....
1925	19.6	16.8	170.5	165.1	69.9	143.7	12.77	31.59	....
1926	12.5	17.9	131.4	117.4	74.5	121.7	13.24	22.04	....
1927	20.2	20.7	101.9	109.0	85.0	119.0	10.29	34.83	....
1928	18.0	20.0	53.2	118.0	84.0	99.8	11.22	34.17	....
1929	16.8	18.3	131.6	117.1	79.9	103.6	10.90	30.92	....
1930	9.5	12.8	91.2	108.1	59.8	67.1	11.06	22.04	....
1931	5.7	8.2	46.0	72.6	32.0	39.0	8.69	8.97	....
1932	6.5	10.5	38.0	54.2	31.9	38.2	6.20	10.33	....
1933	10.2	13.0	82.4	69.4	52.2	74.4	8.09	12.88	....
1934	12.4	21.3	44.6	79.8	81.5	84.8	13.20	33.00	....
1935	11.1	18.4	59.3	70.3	65.5	83.2	7.52	30.54	....
1936	12.4	23.6	114.2	92.9	104.4	102.5	11.20	33.36	....
1937	8.4	20.4	52.9	82.0	51.8	96.2	8.74	19.51	....
1938	8.6	19.6	55.7	73.0	48.6	56.2	6.78	21.79	....
1939	9.1	15.4	69.7	74.9	56.8	69.1	7.94	21.17	....
1940	9.9	16.0	54.1	85.5	61.8	68.2	7.58	21.73	....
1941	17.0	26.4	80.7	94.0	75.1	94.5	9.67	47.65	....
1942	19.0	36.9	117.0	119.0	91.7	109.8	10.80	45.61	....
1943	19.9	40.5	131.0	204.0	112.0	136.0	14.80	52.10	....
1944	20.7	42.0	149.0	192.0	109.0	141.0	16.40	52.70	....
1945	22.4	42.6	139.0	200.0	114.0	149.0	15.10	51.80	....
1946									
August	33.55	48.6	143.0	280.0	180.0	178.0	15.10	59.10	....
September	35.30	48.8	128.0	224.0	173.0	179.0	15.40	57.80	....
October	37.69	53.0	122.0	209.0	171.0	188.0	16.10	66.00	....
November	29.23	43.8	123.0	200.0	127.0	189.0	17.20	89.90	....
December	29.98	43.5	126.0	210.0	122.0	192.0	17.70	91.50	....
1947									
January	29.74	39.0	129.0	220.0	121.0	191.0	17.50	90.40	....
February	30.56	31.9	131.0	228.0	123.0	199.0	17.50	88.20	....
March	31.89	33.6	139.0	235.0	150.0	244.0	17.40	88.00	....
April	32.26	30.1	147.0	233.0	163.0	240.0	17.20	88.00	....
May	33.50	44.6	153.0	233.0	159.0	239.0	16.80	83.70	....
June	34.07	46.0	156.0	249.0	185.0	218.0	16.00	79.60	....
July	35.88	48.5	169.0	251.0	201.0	214.0	15.10	79.00	....
Index Numbers (Aug. 1909–July 1914 = 100)									
1922	185	228	95	114	116	109	98	135	....
1923	231	190	133	137	129	105	110	183	....
1924	185	190	98	170	166	141	107	147	143
1925	158	168	245	188	109	163	108	140	143
1926	101	179	189	134	116	138	112	98	139
1927	163	207	146	124	132	135	87	154	127
1928	145	200	76	134	131	113	95	152	154
1929	135	183	189	133	124	117	92	137	137
1930	77	128	131	123	93	76	93	98	129
1931	46	82	66	83	50	44	73	40	115
1932	52	105	55	62	50	43	52	46	102
1933	82	130	118	79	81	84	68	57	91
1934	100	213	64	91	127	96	111	146	95
1935	90	184	85	80	102	94	63	135	119
1936	100	236	164	106	163	116	94	148	104
1937	68	204	76	93	81	109	74	87	110
1938	69	196	80	83	76	64	57	97	88
1939	73	154	100	85	88	78	67	94	91
1940	80	160	78	97	96	77	64	96	111
1941	137	264	116	107	117	107	81	211	129
1942	153	369	168	136	143	124	91	202	163
1943	160	405	188	232	174	154	125	231	245
1944	167	420	214	219	170	160	138	234	212
1945	181	435	199	228	178	169	127	230	224
1946									
August	287	486	205	319	280	201	127	262	162
September	285	488	184	255	269	202	130	256	154
October	304	530	175	238	266	213	136	293	151
November	236	438	176	228	198	214	145	399	207
December	242	435	181	239	190	217	149	406	166
1947									
January	240	390	185	351	188	216	147	401	238
February	246	319	188	260	192	225	147	391	275
March	257	336	199	268	234	276	147	390	299
April	260	301	211	265	254	271	145	390	295
May	270	446	220	265	248	270	142	371	286
June	275	460	224	284	288	247	135	353	215
July	289	485	242	286	313	242	127	350	189

Wholesale Prices of Ammoniates

	Nitrate of soda per unit N bulk	Sulphate of ammonia bulk per unit N	Cottonseed meal S. E. Mills per unit N	Fish scrap, dried 11–12% ammonia, 15% bone phosphate, f.o.b. factory, bulk per unit N	Tankage 11% ammonia, 15% bone phosphate, f.o.b. Chicago, bulk, per unit N	High grade ground blood, 16–17% ammonia, Chicago, bulk per unit N
1910–14	$2.68	$2.85	$3.50	$3.53	$3.37	$3.52
1923	3.02	2.90	6.19	4.83	4.59	5.16
1924	2.99	2.44	5.87	5.02	3.60	4.25
1925	3.11	2.47	5.41	5.34	3.97	4.75
1926	3.06	2.41	4.40	4.95	4.36	4.90
1927	3.01	2.26	5.07	5.87	4.32	5.70
1928	2.67	2.30	7.06	6.63	4.92	6.00
1929	2.57	2.04	5.64	5.00	4.61	5.72
1930	2.47	1.81	4.78	4.96	3.79	4.58
1931	2.34	1.46	3.10	3.95	2.11	2.46
1932	1.87	1.04	2.18	2.18	1.21	1.36
1933	1.52	1.12	2.95	2.86	2.06	2.46
1934	1.52	1.20	4.46	3.15	2.67	3.27
1935	1.47	1.15	4.59	3.10	3.06	3.65
1936	1.53	1.23	4.17	3.42	3.58	4.25
1937	1.63	1.32	4.91	4.66	4.04	4.80
1938	1.69	1.38	3.69	3.76	3.15	3.53
1939	1.69	1.35	4.02	4.41	3.87	3.90
1940	1.69	1.36	4.64	4.36	3.33	3.39
1941	1.69	1.41	5.50	5.32	3.76	4.43
1942	1.74	1.41	6.11	5.77	5.04	6.76
1943	1.75	1.42	6.30	5.77	4.86	6.62
1944	1.75	1.42	7.68	5.77	4.86	6.71'
1945	1.75	1.42	7.81	5.77	4.86	6.71
1946						
August	2.22	1.46	16.88	8.14	6.07	12.14
September	2.22	1.46	10.32	6.95	6.07	12.14
October	2.22	1.46	13.20	7.12	8.30	12.14
November	2.22	1.46	15.19	11.26	12.14	12.75
December	2.22	1.46	14.63	11.37	12.14	11.17
1947						
January	2.36	1.46	12.98	11.06	12.14	10.32
February	2.41	1.46	10.01	11.06	12.14	10.17
March	2.41	1.46	11.98	11.06	12.50	10.50
April	2.41	1.51	11.72	10.79	12.75	11.39
May	2.41	1.51	10.55	9.98	12.75	8.80
June	2.41	1.51	10.94	9.98	12.75	8.26
July	2.41	1.59	12.56	9.98	12.75	8.66
	Index Numbers (1910-14 = 100)					
1923	112	102	177	137	136	147
1924	111	86	168	142	107	121
1925	115	87	155	151	117	135
1926	113	84	126	140	129	139
1927	112	79	145	166	128	162
1928	100	81	202	188	146	170
1929	96	72	161	142	137	162
1930	92	64	137	141	12	130
1931	88	51	89	112	63	70
1932	71	36	62	62	36	39
1933	59	39	84	81	97	71
1934	59	42	127	89	79	93
1935	57	40	131	88	91	104
1936	59	43	119	97	106	131
1937	61	46	140	132	120	122
1938	63	48	105	106	93	100
1939	63	47	115	125	115	111
1940	63	48	133	124	99	96
1941	63	49	157	151	112	126
1942	65	49	175	163	150	192
1943	65	50	180	163	144	189
1944	65	50	219	163	144	191
1945	65	50	223	163	144	191
1946						
August	83	51	482	231	180	345
September	83	51	295	197	180	345
October	83	51	377	202	246	345
November	83	51	434	319	360	362
December	83	51	418	322	360	317
1947						
January	88	51	371	313	360	293
February	90	51	286	313	360	289
March	90	51	342	313	371	298
April	90	53	335	306	378	324
May	90	53	301	283	378	250
June	90	53	313	283	378	234
July	90	56	359	283	378	246

Wholesale Prices of Phosphates and Potash **

	Superphosphate Baltimore, per unit	Florida land pebble 68% f.o.b. mines, bulk, per ton	Tennessee phosphate rock, 75% f.o.b. mines, bulk, per ton	Muriate of potash bulk, per unit, c.i.f. Atlantic and Gulf ports	Sulphate of potash in bags, per unit, c.i.f. Atlantic and Gulf ports	Sulphate of potash magnesia, per ton, c.i.f. Atlantic and Gulf ports	Manure salts bulk, per unit, c.i.f. Atlantic and Gulf ports[1]
1910–14	$0.536	$3.61	$4.88	$0.714	$0.953	$24.18	$0.657
1923	.550	3.08	7.50	.588	.836	23.32	....
1924	.502	2.31	6.60	.582	.860	23.72	....
1925	.600	2.44	6.16	.584	.860	23.72	....
1926	.598	3.20	5.57	.596	.854	23.58	.537
1927	.525	3.09	5.50	.646	.924	25.55	.586
1928	.580	3.12	5.50	.669	.957	26.46	.607
1929	.609	3.18	5.50	.672	.962	26.59	.610
1930	.542	3.18	5.50	.681	.973	26.92	.618
1931	.485	3.18	5.50	.681	.973	26.92	.618
1932	.458	3.18	5.50	.681	.963	26.90	.618
1933	.434	3.11	5.50	.662	.864	25.10	.601
1934	.487	3.14	5.67	.486	.751	22.49	.483
1935	.492	3.30	5.69	.415	.684	21.44	.444
1936	.476	1.85	5.50	.464	.708	22.94	.505
1937	.510	1.85	5.50	.508	.757	24.70	.556
1938	.492	1.85	5.50	.523	.774	15.17	.572
1939	.478	1.9	5.50	.521	.751	24.52	.570
1940	.516	1.90	5.50	.517	.730	24.75	.573
1941	.547	1.94	5.64	.522	.780	25.55	.570
1942	.600	2.13	6.29	.522	.810	25.74	.205
1943	.631	2.00	5.93	.522	.786	25.35	.195
1944	.645	2.10	6.10	.522	.777	25.35	.195
1945	.650	2.20	6.23	.522	.777	25.35	.195
1946							
August	.700	2.60	6.60	.471	.729	22.88	.176
September	.700	2.60	6.60	.471	.729	22.88	.176
October	.700	2.60	6.60	.471	.729	22.88	.176
November	.700	2.60	6.60	.535	.797	26.00	.200
December	.700	2.60	6.60	.535	.797	26.00	.200
1947							
January	.700	2.60	6.60	.535	.797	26.00	.200
February	.720	2.60	6.60	.535	.799	26.00	.200
March	.740	2.75	6.60	.535	.797	26.00	.200
April	.740	2.97	6.60	.535	.797	26.00	.200
May	.740	2.97	6.60	.535	.797	26.00	.200
June	.752	2.97	6.60	.330	.589	12.76	.176
July	.760	2.97	6.60	.353	.629	13.63	.188
Index Numbers (1910-14 = 100)							
1923	103	85	154	82	88	96	....
1924	94	64	135	82	90	98	....
1925	110	68	126	82	90	98	....
1926	112	88	114	83	90	98	82
1927	100	86	113	90	97	106	89
1928	108	86	113	94	100	109	92
1929	114	88	113	94	101	110	93
1920	101	88	113	95	102	111	94
1931	90	88	113	95	102	111	94
1932	85	88	113	95	101	111	94
1933	81	86	113	93	91	104	91
1934	91	87	110	68	79	93	74
1935	92	91	117	58	72	89	68
1936	89	51	113	65	74	95	77
1937	95	51	113	71	79	102	85
1938	92	51	113	73	81	104	87
1939	89	53	113	73	79	101	87
1940	96	53	113	72	77	102	87
1941	102	54	110	73	82	106	87
1942	112	59	129	73	85	106	84
1943	117	55	121	73	82	105	83
1944	120	58	125	73	82	105	83
1945	121	61	128	73	82	105	83
1946							
August	131	72	135	66	76	95	80
September	131	72	135	66	76	95	80
October	131	72	135	66	76	95	80
November	131	72	135	75	84	108	83
December	131	72	135	75	84	108	83
1947							
January	131	72	135	75	84	108	83
February	134	72	135	75	84	108	83
March	138	76	135	75	84	108	83
April	138	82	135	75	84	108	83
May	138	82	135	75	84	108	83
June	140	82	135	60	62	53	80
July	142	82	135	64	66	56	82

Combined Index Numbers of Prices of Fertilizer Materials, Farm Products and All Commodities

	Farm prices*	Prices paid by farmers for commodities bought*	Wholesale prices of all commodities†	Fertilizer material‡	Chemical ammoniates	Organic ammoniates	Superphosphate	Potash**
1923	143	152	147	114	107	144	103	79
1924	143	152	143	103	97	125	94	79
1925	156	156	151	112	100	131	109	80
1926	146	155	146	119	94	135	112	86
1927	142	153	139	116	89	150	100	94
1928	151	155	141	121	87	177	108	97
1929	149	154	139	114	79	146	114	97
1930	128	146	126	105	72	131	101	99
1931	90	126	107	83	62	83	90	99
1932	68	108	95	71	46	48	85	99
1933	72	108	96	70	45	71	81	95
1934	90	122	109	72	47	90	91	72
1935	109	125	117	70	45	97	92	63
1936	114	124	118	73	47	107	89	69
1937	122	131	126	81	50	129	95	75
1938	97	123	115	78	52	101	92	77
1939	95	121	112	79	51	119	89	77
1940	100	122	115	80	52	114	96	77
1941	124	131	127	86	56	130	102	77
1942	159	152	144	93	57	161	112	77
1943	192	167	151	94	57	160	117	77
1944	195	176	152	96	57	174	120	76
1945	202	180	154	97	57	175	121	76
1946								
August	249	214	187	116	67	293	131	70
September	243	210	181	108	67	223	131	70
October	273	218	197	115	67	286	131	70
November	263	224	198	127	67	382	131	78
December	264	225	204	127	67	376	131	78
1947								
January	260	227	206	126	69	359	131	78
February	262	234	209	124	70	329	134	78
March	280	240	216	128	70	354	138	78
April	276	243	215	129	71	354	138	78
May	272	242	215	127	71	339	138	78
June	271	244	215	125	71	343	140	63
July	276	244	219	128	72	359	142	67

* U. S. D. A. figures. Beginning January 1946 farm prices and index numbers of specific farm products revised from a calendar year to a crop-year basis. Truck crops index adjusted to the 1924 level of the all-commodity index.

† Department of Labor index converted to 1910-14 base.

‡ The Index numbers of prices of fertilizer materials are based on original study made by the Department of Agricultural Economics and Farm Management Cornell University, Ithaca, New York. These indexes are complete since 1897. The series was revised and reweighted as of March 1940 and November 1942.

[1] Since June 1941, manure salts are quoted F.O.B. mines exclusively.

**** The weighted average of prices actually paid for potash are lower than the annual average because since 1926 over 90% of the potash used in agriculture has been contracted for during the discount period. Since 1937, the maximum discount has been 12%. Applied to muriate of potash, a price slightly above $.471 per unit K_2O thus more nearly approximates the annual average than do prices based on arithmetical averages of monthly quotations.**

REVIEWS

This section contains a short review of some of the most practical and important bulletins, and lists all recent publications of the United States Department of Agriculture, the State Experiment Stations, and Canada, relating to Fertilizers, Soils, Crops, and Economics. A file of this department of BETTER CROPS WITH PLANT FOOD would provide a complete index covering all publications from these sources on the particular subjects named.

Fertilizers

"Fertilizing Materials, 1946," Bu. of Chem., Dept. of Agr., Sacramento 14, Calif., Spec. Publ. 220.

"Commercial Fertilizer Sales as Reported to Date for Quarter Ended March 31, 1947," Bu. of Chem., Dept. of Agr., Sacramento, Calif., FM-142, May 26, 1947.

"Agricultural Mineral Sales as Reported to Date for Quarter Ended March 31, 1947," Bu. of Chem., Dept. of Agr., Sacramento 14, Calif., FM-143, May 26, 1947.

"Grades of Mixed Fertilizers in California," Bu. of Chem., Dept. of Agr., Sacramento 14, Calif., FM-147, June 2, 1947.

"Handbook of Commercial Fertilizers and Soil Amendments," Ext. Serv., Colorado A & M, Fort Collins, Colo., Bul. 393-A, April 1947, R. S. Whitney and R. H. Tucker.

"Fertilizer Studies with the Red McClure and Bliss Triumph Varieties of Potatoes in the San Luis Valley," Agr. Exp. Sta., Colorado A & M, Fort Collins, Colo., Tech. Bul. 35, April 1947, J. G. McLean, W. C. Sparks, and A. M. Binkley.

"Tonnage of Different Grades of Fertilizers Sold in Delaware, 1946," Agr. Exp. Sta., Dover, Delaware, C. E. Phillips.

"Results of Fertilizer Tests with Corn in Georgia During 1946," Agr. Exp. Sta., Experiment, Ga., Press Bul. 585, March 28, 1947, L. C. Olson and O. L. Brooks.

"Report of Analysis of Commercial Fertilizers," Dept. of Agr. and Immigration, Baton Rouge, La., 1945-1946.

"Commercial Fertilizers, 1946," Agr. Exp. Sta., Orono, Maine, Official Inspections 201, Oct. 1946, E. R. Tobey.

"Tung Fertilization," Agr. Exp. Sta., Miss. State College, State College, Miss., Inf. Sheet 379, Nov. 1946, W. W. Kilby.

"Boron Deficiency of Cabbage," Agr. Exp. Sta., Miss. State College, State College, Miss., Inf. Sheet 382, Dec. 1946, J. A. Campbell.

"New Developments in Fertilizing Corn," Agr. Exp. Sta., Miss. State College, State College, Miss., Inf. Sheet 386, Feb. 1947, H. V. Jordan.

"Commercial Fertilizer Report for 1946," Agr. Exp. Sta., Montana State College, Bozeman, Montana, Bul. 441, Jan. 1947, A. H. Kruse and P. C. Gaines.

"The Response of Clover and Total Forage to Top-Dressing Fertilizers," Agr. Exp. Sta., Univ. of N. H., Durham, N. H., Sta. Cir. 74, May 1947, F. S. Prince, P. T. Blood, and G. P. Percival.

"Commercial Fertilizer Law and Regulations," State Dept. of Agr., Charleston, W. Va., Bul. (n.s.) 54, June 8, 1947.

"Commercial Fertilizers—1946," State Dept. of Agr., Madison, Wis., Bul. 271, May 1946, W. B. Griem.

"Commercial Fertilizers—1947," State Dept. of Agr., Madison, Wis., Bul. 279, Jan. 1947, W. B. Griem.

"Role of Potash in Growth and Nutrition of Maryland Tobacco," U. S. D. A., Washington, D. C., Tech. Bul. 933, April 1947, J. D. Bowling and D. E. Brown.

Soils

"Soil Properties Contributing to Citrus Chlorosis as Revealed by Seedling Tests," Agr. Exp. Sta., Univ. of Ariz., Tucson, Ariz., Tech. Bul. 112, Sept. 1946, W. T. McGeorge.

"Physical Land Conditions on the Queen Creek Soil Conservation District, Arizona," Agr. Exp. Sta., Univ. of Ariz., Tucson, Ariz., Tech. Bul. 113, Dec. 1946, E. C. Nielson, W. G. Harper, and H. V. Smith.

"Soil Survey of Durham County," Dominion Dept. of Agr., Guelph, Ontario, Canada, Rpt. No. 9, Dec. 1946, L. R. Webber, F. F. Morwick, and N. R. Richards.

"Soil Reaction (pH), Some Critical Factors in Its Determination, Control and Significance," Agr. Exp. Sta., Univ. of Fla., Gainesville, Fla., Bul. 400, Aug. 1944, G. M. Volk and C. E. Bell.

"How Productive are the Soils of Central Illinois?" Agr. Exp. Sta., Univ. of Ill., Urbana, Ill., Bul. 522, March 1947, R. T. Odell.

"Supplement to Kankakee County Soil Map and Report (No. 13)," Agr. Exp. Sta., Univ. of Ill., Urbana, Ill., March 1947, Herman Wascher, E. P. Whiteside, and R. S. Smith.

"Cass County Soils," Agr. Exp. Sta., Univ. of Ill., Urbana, Ill., Soil Rpt. 71, March 1947, G. D. Smith, F. F. Riecken, and R. S. Smith.

"Soil Fertility and Conservation, A Minnesota Program," Agr. Ext. Serv., Univ. of Minn., St. Paul, Minn., Ext. Bul. 254, March 1947, P. M. Burson, C. O. Rost, and E. R. Duncan.

"Conservation and Land Use Investigations," Agr. Exp. Sta., Okla. A. & M., Stillwater, Okla., Sta., Bul. B-309, May 1947.

"Improving Garden Soil Fertility," Ext. Serv., Okla. A. & M., Stillwater, Okla., Cir. 448, E. L. Whitehead.

"Sheet Erosion on Two Vermont Soil Types," Agr. Exp. Sta., Univ. of Vt., Burlington, Vt., Bul. 538, May 1947, J. B. Kelly and A. R. Midgley.

"Third Report of the Vermont State Soil Conservation Committee—July 1, 1944-June 30, 1946," State Soil Conservation Committee, Burlington, Vt.

"Methods of Soil Analysis for Soil-Fertility Investigations," U.S.D.A., Washington, D. C., Cir. 757, April 1947, Michael Peech, L. T. Alexander, L. A. Dean, and J. Fielding Reed.

"When Drought Returns to the Great Plains," U.S.D.A., Washington, D. C., Farmers' Bul. 1982, March 1947, Tom Dale.

"Black Alkali Reclamation," U.S.D.A., Soil Conservation Serv., Region 6, Reg. Bul. 101, Soil Series 8, Jan. 1947, C. H. Diebold and J. A. Downs.

"Use of Sulfur on Dispersed Soils," U.S.D.A., Washington, D. C., Reg. Bul. 102, Soil Series 9, Dec. 1946, C. H. Diebold and Glenn Niner.

Crops

"More Corn per Acre and How to Grow It," Ext. Serv., Ala. Polytechnic Inst., Auburn, Ala., Cir. 272, Jan. 1947, J. C. Lowery and D. R. Harbor.

"Annual Lespedeza in Alabama," Ext. Serv., Ala. Polytechnic Inst., Auburn, Ala., Cir. 319, Jan. 1946, J. C. Lowery and D. R. Harbor.

"Grow Lespedeza Sericea," Ext. Serv., Ala. Polytechnic Inst., Auburn, Ala., Cir. 320, Jan. 1946, J. C. Lowery and D. R. Harbor.

"Our Goal, A Bale or More per Acre," Ext. Serv., Ala. Polytechnic Inst., Auburn, Ala., Cir. 324, rev. Jan. 1947, J. T. Belue and J. C. Lowery.

"How to Manage Your Fish Pond," Ext. Serv., Ala. Polytechnic Inst., Auburn, Ala., Cir. 325, rev. Feb. 1947, A. M. Pearson.

"The Experiment Station Reports," Agr. Exp. Sta., Univ. of Ark., Fayetteville, Ark., Bul. 464, Dec. 1946.

"Hints for the Gardener," Ext. Serv., Univ. of Ark., Fayetteville, Ark., Leaf. 50, rev. 1946.

"1946 Arkansas Corn Yield Tests," Agr. Exp. Sta., Univ. of Ark., Fayetteville, Ark., Rpt. Series No. 6, Feb. 1947, D. B. Shank and B. D. McCollum.

"Twenty-Seventh Annual Report, Period Ending December 31, 1946," State Dept. of Agr., Sacramento, Calif., Vol. XXXV, No. 4.

"Production of Easter Lily Bulbs," Agr. Ext. Serv., Univ. of Calif., Berkeley, Calif., Cir. 132, Feb. 1947, H. M. Butterfield.

"Raspberry and Blackberry Culture," Hort. Exp. Sta., Ontario Dept. of Agr., Toronto, Ontario, Can., Bul. 355, rev. March 1947, W. J. Strong.

"NPK, Put It Back," 59th A. R., Agr. Exp. Sta., Colorado A. & M., Fort Collins, Colo.

"Small Fruits in the Home Garden," Ext. Serv., Colorado A. & M., Fort Collins, Colo., Cir. 143-A, Nov. 1946.

"Adapted Vegetable Varieties for Colorado," Ext. Serv., Colorado A. & M., Fort Collins, Colo., Cir. 146-A, March 1947.

"Colorado Lawns, Planting and Maintenance," Ext. Serv., Colorado A. & M., Fort Collins, Colo., Bul. 392-A, Jan. 1947.

"Tobacco Substation at Windsor, Report for 1946," Agr. Exp. Sta., New Haven, Conn., Bul. 504, Feb. 1947, P. J. Anderson, T. R. Swanback, and A. B. Pack.

"1946 Report, Florida Agricultural Extension Service," Gainesville, Fla.

"Peanut Curing Studies," Ga. Exp. Sta., Experiment, Ga., Bul. 255, June 1947, W. K. Bailey, T. A. Pickett, and J. G. Futral.

"Annual Report, 1945," Agr. Ext. Serv., Univ. of Ga., Athens, Ga., Bul. 530, April 1946.

"Strawberry Culture," Agr. Ext. Serv., Univ. of Ga., Athens, Ga., Cir. 335, Feb. 1947, G. H. Firor.

"4-H Club Project Guide Book," Agr. Ext. Serv., Univ. of Ga., Athens, Ga., Bul. 534, June 1946.

"Growing Blackberries and Dewberries," Ga. Exp. Sta., Experiment, Ga., Press Bul. 586, April 21, 1947, B. O. Fry.

"Growing Pimientos," Ga. Exp. Sta., Experiment, Ga., Press Bul. 587, April 21, 1947, W. H. Greenleaf and F. F. Cowart.

"Twenty-Ninth Annual Report," State Dept. of Agr., Springfield, Ill.

"Lincoln, A Midseason Soybean for the North-Central States," Agr. Exp. Sta., Univ. of Ill., Urbana, Ill., Bul. 520, Jan. 1947, C. M. Woodworth and L. F. Williams.

"Two New Illinois Inbred Lines of Corn," Agr. Exp. Sta., Univ. of Ill., Urbana, Ill., Bul. 523, May 1, 1947, R. W. Jugenheimer, E. R. Leng, and C. M. Woodworth.

Economics

"Fruit and Vegetable Concentration Markets in North Carolina, South Carolina, Georgia, and Alabama," Exp. Sta., Univ. of Ga., Experiment, Ga., Bul. 245, July 1946.

"When Father and Son Farm Together," Ext. Serv., Univ. of Maine, Orono, Maine, Bul. 354, April 1947, M. D. Jones.

"Extension Works With Rural People," Ext. Serv., Univ. of Maine, Orono, Maine, Bul. 360, May 1947.

"Michigan Vegetable Survey," State Dept. of Agr., Lansing, Mich., June 1947, J. R. Garrett and M. E. Cravens.

"The Agricultural Outlook for Missouri, 1947," Agr. Ext. Serv., Univ. of Mo., Columbia, Mo., Manual 42, Feb. 1947, G. B. Nance.

"Changing Aspects of the Farm Real Estate Situation in Montana, 1940 to 1946," Agr. Exp. Sta., Montana State College, Bozeman, Mont., Bul. 440, Jan. 1947, L. S. Thompson.

"Seven Principles of Successful Farming in Oklahoma," Ext. Serv., Okla. A & M, Stillwater, Okla., Cir. 446.

"Profitable Farming Practices," Agr. Ext. Serv., Pa. State College, State College, Pa., Cir. 275, Apr. 1945, E. L. Moffitt and M. J. Armes.

"Subsistence on the Small Farm, with Special Reference to the Cumberland Plateau," Agr. Exp. Sta., Univ. of Tenn., Knoxville, Tenn., Bul. 201, Aug. 1946, J. J. Bird, E. L. Bohanan, and Jane K. Hale.

"The People and Their Use of Land in Nine Vermont Towns," Agr. Exp. Sta., Univ. of Vt., Burlington, Vt., Bul. 536, Apr. 1947, R. M. Carter.

"Fruit Farm Management," College of Agr., Univ. of Vt., Burlington, Vt., Brieflet No. 769, Sheldon Williams.

"The Balance Sheet of Agriculture, 1946," Bu. of Agr. Econ., U.S.D.A., Washington, D. C., Misc. Publ. 620, Jan. 1947.

"Statistics of Farmers' Marketing and Purchasing Cooperatives, 1944-45," Farm Credit Admin., U.S.D.A., Washington, D. C., Misc. Rpt. 108, May 1947, Grace Wanstall.

"Cotton Quality Statistics, United States, 1945-46," Prod. and Marketing Admin., U.S.D.A., Washington, D. C., CS-21, Dec. 1946.

"Cotton Futures Statistics, August 1942-July 1945," Prod. and Marketing Admin., U.S.D.A., Washington, D. C., CS-22, Jan. 1947.

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Reshaping New England Farm Land

(*From page* 22)

hauling them away. This method is particularly applicable in cases where the stones must be removed distances greater than one-quarter of a mile. Shattering of large boulders with dynamite or by heat facilitates their removal by trucks.

Woodland and pastures are being cleared of trees and brush with bulldozers. Uncut large trees are more easily removed than are their stumps, because of the leverage effect gained by the trunk and top. Removal of roots after the trees are cut is a costly job and often as expensive as removal of the trees. Woodland is being cleared at costs varying from $50 to $150 per acre, and pastures with brush and small trees at $20 to $50 per acre. The bulldozer has been found especially adapted to the removal of filler apple trees, which have been removed at 21 to 32 cents per tree.

Land drainage is a high priority problem in New England. Much long-needed work in this field is now being undertaken in this area. There are the small simple jobs on individual farms and the more complicated large community projects involving a number of farms. Soil conservation districts are facilitating drainage work in a big way. Technicians of the Soil Conservation Service are doing the necessary preliminary engineering, and district supervisors are providing either district-owned excavating equipment or the service of private contractors for doing the job. Many of the smaller ditches are being blasted with dynamite. Drainage ditches are being blasted in Massachusetts at a cost to the farmer of 10 cents per linear foot. An advantage of blasting is that no spoil bank is left. For the larger main ditches required in a group drainage project, a dragline or power shovel is the most practical means of excavating. Costs of dragline excavations for drainage in Vermont have been reported from 7 cents to 15 cents per cubic yard.

The construction of farm ponds is still another way in which New England farm land is being reshaped. Although nature endowed this section with thousands of lakes and ponds, there is need for many thousand more small ponds. They are needed for stock water, fire fighting, fish supply, and recreation. A pond for each farm is the goal of one leading insurer of farm

buildings. Ponds are constructed with bulldozers and draglines for the most part, but some jobs may be done by blasting. Cost of ponds may vary from $35 to $1,000 or more, depending on size, soil, and terrain.

A confidential note for tourists: The face of New England is not being changed so much or in such way as to rob it of its charm. Changes are occurring slowly but surely, and it is the belief of some landscape artists that the curves and contours incidental to conservation farms will enhance the beauty of the justly famous New England landscape.

Analyzing the Soils of Northwest Louisiana

(*From page* 12)

Corn: 50 pounds of 50 per cent muriate of potash, side-dressed with 300 to 400 pounds of nitrate of soda or equivalent an acre.

Oats: 50 pounds of 50 per cent muriate of potash, top-dressed with 300 to 400 pounds of nitrate of soda or equivalent an acre.

Alfalfa: 100 pounds of 50 per cent muriate of potash an acre.

Clover-grass pasture: 50 pounds of 50 per cent muriate of potash an acre.

The laboratory doesn't test for available nitrogen. Nitrogen compounds are unstable in the soil and the available nitrogen will vary greatly at different times of the year. The potential supply of nitrogen in the soils of this area is generally less than .03 per cent, which is an exceedingly short supply. All the soils of this area respond to the application of nitrogen.

If crops are to yield their maximum, the soils' mineral shortages will have to be corrected. The most exact method of determining these deficiencies is by soil analyses. Since most farms have many soils, and since each field has been handled differently in the past, a number of soil samples have to be taken on a farm before a proper over-all fer-

Fig. 3. This shows the effect of continuous row crops. Nothing was returned to the soil. Erosion resulted plus social and economic damage. The family had to move away. It is to avoid conditions like these that Soil Conservation technicians and Louisiana State Soils Laboratory men are working to get the proper fertilizers put in the soils.

tilization program can be carried out. Even if all the necessary elements are made available to plants in a soil, a good crop is not assured. Cultivation methods, plant diseases, insects, noxious weeds, the weather, soil tilth, and other factors have to be reckoned with.

Many farmers of northwestern Louisiana are realizing that their margin of profit in crop production actually depends on the proper use of fertilizers. They are beginning to profit from the services rendered by the State soils laboratory. Soil conservation district cooperators who follow the State soils laboratory fertilizer recommendations, along with their other soil conservation district practices, have obtained outstanding results in quality and quantity of crops produced.

They report pastures that will sustain a cow to one and one-half acres; originally it took seven acres of that land to feed a cow. Oat yields are up to 60 bushels an acre; 30 bushels is considered a good yield on the same soil. Corn yields reach 60 bushels an acre; the State average is 17 bushels.

The soil is the foundation of agriculture. Better crops, better livestock, and the assurance of a nutritious diet to human beings will result with proper fertilization, an integral part of the soil conservation program.

Fertilizing Potatoes . . . Aroostook County, Maine

(*From page* 26)

low in P_2O_5 caused the average response of this group to be quite low. The zero P_2O_5 treatment was omitted on most of the soils having a low or medium P_2O_5 content, so that response to the first increment of P_2O_5 (40 pounds) was not measured. The highest amount of P_2O_5 was likewise omitted on most of the soils medium to high in P_2O_5. No yield increase was obtained from applications of P_2O_5 greater than 160 pounds per acre at any location. On soils high in readily soluble P_2O_5, maximum response was obtained with 80 pounds P_2O_5 per acre.

Of the eleven rate tests of K_2O completed, two were located on soils low in exchangeable K_2O, three on soils rated as medium, and six having a high content of K_2O. As shown in Table 3, there was little response in yield of potatoes to applied K_2O, even on the soils low in this plant food. In no case was there a significant response to any rate tested, although a zero K_2O treatment was not included in these experiments. Lack of adequate moisture for potatoes in August may have been a factor in the low response to potash fertilization at all fertility levels.

Results from Fertilizer Experiments in 1946

In 1946, nine rate tests of P_2O_5 were completed. Of these, seven were on soils low in content of residual P_2O_5 and two on soils rated high in P_2O_5. None of those completed were on soils having a medium content of P_2O_5. As shown in Table 4, response of potatoes to P_2O_5 was marked on soils having a low readily soluble P_2O_5 content. Average increases in yields for the seven tests were obtained for all rates of P_2O_5 included in the comparisons. Much less response to P_2O_5 was obtained on the soils high in P_2O_5, no response being obtained to rates above 120 pounds of P_2O_5 per acre.

Of the eight rate tests of K_2O completed, three were on soils low in residual K_2O, three on medium, and two on soils high in K_2O. Table 5 gives the relative response of potatoes to K_2O on the different groups of soils. As may be noted in the table, there was little or no response to K_2O above 120 pounds per acre for any of the fertility levels. Significant decreases in yield resulted in some of the tests from higher rates

of potash fertilization. Another effect of excessive rates of application of K_2O in 1946 was noted on the starch content of the tubers, as measured by determination of specific gravity. As an average of four field tests, application of 300 pounds K_2O per acre decreased the starch content of tubers about two per cent, as compared to tubers from the zero potash treatments. Since the tubers receiving no potash contained approximately 14 per cent starch, an appreciable reduction in quality resulted from the heavy application of potash. Eating quality, content of dry matter, and mealiness are fairly closely related to the starch content.

Discussion of Results

Results obtained from fertilizer experiments in 1945 and 1946 indicate that considerably more phosphorus and potash fertilizer is commonly applied in Aroostook County for potatoes than is necessary for efficient production. Similar results were obtained in less extensive experiments conducted in 1943 and 1944. The lack of response to potash in the experiments was most noticeable. Out of the total of 28 potash rate tests conducted during the four-year period on soils of widely varying contents of exchangeable K_2O, potatoes showed a response to applications of more than 100 to 120 pounds of K_2O per acre in only eleven tests. In these tests increases in yield from applications up to 180 to 200 pounds K_2O per acre were obtained in seven tests. In only one test in 28 was there a response to more than 200 pounds K_2O per acre. Most of the soils on which increases in yield from rates of above 120 pounds K_2O per acre were obtained were low in exchangeable K_2O. In several of the tests, however, especially in 1945, some of the cases of lack of response may be attributed to lack of moisture in August. This does not explain lack of response in some tests in 1946, since in this year high yields of potatoes were obtained with adequate fertilization in all experiments where the stand was adequate.

From the estimates in Table 1, indicating that about 89 per cent of the normal application of P_2O_5 for potatoes is left in the soil, it might be supposed that more phosphorus is also being applied than is needed for the crop. Results of the experiments, however, indicated responses in many cases up to 160 or 200 pounds of P_2O_5 per acre. Since even a large crop utilizes only a small portion of these amounts, this response, especially on some soils high in residual P_2O_5, is not clear. An explanation of the response to heavy applications of P_2O_5 may perhaps be associated with the need of the potato plant, with its limited root development, for a relatively large supply of readily soluble phosphorus early in its growth period. Another cause may be the effect of phosphorus in reducing the harmful effects on the plant of soluble aluminum, manganese, or other toxic factors in the rather acid soil in which potatoes are commonly grown.

Much of the tonnage of fertilizer used on potatoes in Maine has been in grades having high ratios of potash such as 1-2-3, 2-3-4, 2-3-5, or 2-4-5. Equivalent grades or approximate ones

TABLE 4. RELATIVE RESPONSE OF KATAHDIN POTATOES IN 1946 TO P_2O_5 ON SOILS HAVING DIFFERENT LEVELS OF RESIDUAL P_2O_5.

Fertilizer treatment	Relative[1] response to fertilization	
Pounds per acre of N–P_2O_5–K_2O	Soils low in P_2O_5 (Av. 7 tests)	Soils high in P_2O_5 (Av. 2 tests)
100– 0–200...	68	96
100– 40–200...	88	100
100– 80–200...	95	103
100–120–200...	98	105
100–160–200...	100	100
100–200–200...	104	103

[1] Average yields taken for 2,000 pounds of 5-8-10 fertilizer as 100 are: low soils—473, and high soils —485 bushels per acre. This difference is due not only to difference in soil fertility but also to location, weather, etc.

TABLE 5. RELATIVE RESPONSE OF KATAHDIN POTATOES IN 1946 TO K_2O ON SOILS HAVING DIFFERENT LEVELS OF RESIDUAL K_2O.

Fertilizer treatment Pounds per acre of N–P_2O_5–K_2O	Relative[1] response to fertilization		
	Soils low in K_2O (Av. 3 tests)	Soils medium in K_2O (Av. 3 tests)	Soils high in K_2O (Av. 2 tests)
100–160– 0...	87	94	90
100–160– 60...	96	99	95
100–160–120...	97	102	99
100–160–180...	100	100	100
100–160–240...	100	99	99
100–160–300...	97	99	102

[1] Average yields taken for 2,000 pounds of 5-8-9 fertilizer as 100 are: low soils—515, medium soils—475, and high soils—498 bushels per acre. These differences are due to difference in location, weather, etc.

are 5-7-10, 5-8-12, 6-9-15, 8-12-16, 8-12-20, or 8-16-20. The 1-2-2 ratio such as in the 5-10-10, 8-16-16, or 5-8-7 grades, having equal or approximately equal amounts of P_2O_5 and K_2O, have been or still are popular. During the war period when prices have been favorable, applications of 2,500 pounds of 5-7-10 per acre, 2,000 pounds of 6-9-15, 1,500 pounds of 8-12-16, 8-12-20, or 8-16-20, or even 2,000 pounds of 8-16-16 have been common with many farmers. In terms of pounds of plant food per acre the equivalent amounts range as high as 160 pounds of N, 320 pounds of P_2O_5, and 320 pounds of K_2O per acre. Some farmers apply even larger amounts than these.

In the rate tests of P_2O_5 and K_2O it was found that 160 to 200 pounds of P_2O_5 and K_2O were adequate on practically all of the soils on which experiments were conducted. In order to supply these amounts of P_2O_5 and K_2O from the fertilizer grades commonly used, from 80 to 100 pounds of N or less would be applied in the fertilizer. Other experiments have shown that 100 to 120 pounds of N per acre usually give a maximum return. To give a more nearly correct proportion of plant food in the fertilizer for potatoes in Aroostook County, then, it appears that a 2-3-3 ratio would be more satisfactory on most soils than any now mixed for the potato farmer. An application of 1,500 pounds of 8-12-12 or 2,000 pounds of 6-9-9 would supply 120 pounds of N and 180 pounds each of P_2O_5 and K_2O per acre. These amounts of P_2O_5 and K_2O are in line with the results from fertilizer experiments. This amount of fertilizer would supply somewhat more N and K_2O and much more P_2O_5 than is normally removed by moderate to high yields of tubers. A larger amount of potash than 180 to 200 pounds per acre may increase yields of potatoes on soils quite low in potassium. However, potato soils in Aroostook County which are low in potassium are almost invariably also low in phosphorus. On these soils a 1-2-2 fertilizer ratio such as in the 8-16-16 grade, when applied at a rate to furnish 120 pounds of nitrogen, should give best results. Where an application of less than 120 pounds of nitrogen is desired, such as following a legume crop or where potatoes are harvested early for seed, the 1-2-2 ratio should also be used.

On soils quite high in both residual phosphorus and potassium, it appears that a 1-1-1 fertilizer ratio would be most efficient. An application of 1,200 pounds of 10-10-10 would supply 120 pounds each of N, P_2O_5, and K_2O. At this rate of application, K_2O would be removed from the soil in larger amount than is added in the fertilizers. In periods of low net returns, however, the farmer might well consider the utilization of some of the residual fertility being accumulated in most potato soils in Maine.

There are certain cases in which a 2-3-4 fertilizer ratio may be more desirable than those containing less potash. One case is where a crop such as peas, which usually removes about 75 to 100 pounds of K_2O per acre, is grown in

the rotation. Application of additional potash for the pea crop should prove desirable to prevent depletion of potassium in the soil to a low level. Another possibility for applying less P_2O_5 than K_2O for potatoes is that of applying the phosphate in a more efficient manner than any method now commonly used. There is considerable experimental evidence that applying the phosphate in a band with or near the seed piece is a more efficient method than applying it in side bands and much more efficient than applying it broadcast. Experiments are now under way to obtain more information on this point. There is also experimental evidence that certain potato varieties need less phosphorus than others. For example, the Green Mountain variety has been found to respond much less to phosphorus than do Katahdins and certain other varieties.

Although many farmers believe that they are obtaining increased yields of potatoes from excessive applications of P_2O_5 and K_2O, carefully conducted experiments have not substantiated this belief. It is more likely that where such increases are being obtained most of them are due to the larger amount of nitrogen in the fertilizer. Much of the phosphoric acid and potash now being used inefficiently as excessive applications for potatoes might well be used to grow better pasture, hay, and other feed crops. Much of the pasture and hay land of the Northeast is in a very low state of fertility, a condition which is certainly an important factor contributing to the high cost of production of livestock products in this region.

Minor Plant Nutrients

(*From page* 18)

ganese, particularly the soils which contain a large quantity of nitrates such as organic soils. Heavy applications of agricultural lime may significantly decrease the solubility and availability of the manganese in certain soils. Under most conditions an application of the equivalent of 25 to 50 pounds of manganese sulphate or other soluble manganese salts will supply the annual requirements for manganese for most crops. The most convenient method of adding soluble manganese is through mixed fertilizer or an application of basic slag which contains a considerable quantity of available manganese.

Zinc as a Nutrient

Since zinc is present in small quantities in most soils and is one of the relatively weak nutrient ions, it is difficult to predict the conditions determining the availability of sufficient zinc for optimum growth of different crops grown under various soil conditions. The solubility value for certain zinc compounds suggests some of the major factors which affect the available zinc supply at different pH values. The solubility values for zinc carbonate and hydroxide indicate that soil with a high pH value usually would have a low availability of zinc. Since the solubility of zinc hydroxide is very low, it is not difficult to understand why it is often impossible to secure a response from adding zinc to soils with a relatively high hydroxide content. The very high solubility of zinc nitrate shows why the quantity of nitrogen supply in the soil may affect the solubility of the zinc in the soil. The presence of nitrates in the soil solution would significantly increase the solubility and availability of the zinc in the soil. The presence of chloride or sulphate ions in the soil solution would have an effect similar to nitrate on

the solubility and availability of zinc in the soil.

The addition of zinc to soils with a relatively low pH value or a relatively high content of nitrate, chloride, or sulphate ions may result in an increase in solubility and an adequate supply of available zinc for many crops. The addition of nitrates, chlorides, or sulphates in fertilizers may result in the depletion of the native supply of zinc in the soil through leaching. The relatively low mobility of zinc in the soil and the low intensity of the absorption of the weak zinc ions by most plants suggest the response of certain plants, particularly the tree crops, to applications of zinc to foliage in spray solutions.

Iron

The relatively large quantity and the widespread distribution result in an adequate total supply of iron in most soils. The low solubility of iron hydroxide shown in Table 1 and the relatively low intensity of absorption of the weak iron ion by most plants, particularly in the presence of the stronger cations such as potassium and calcium, suggest some of the reasons for a deficiency of iron under certain soil conditions. Excessive quantities of lime and a marked increase in the hydroxide content of the soil solution will significantly decrease the solubility and availability of iron in many soils, particularly those low in organic matter and nitrogen. The incorporation of organic matter and the addition of nitrogen will usually increase the availability of iron by the formation of iron nitrate or other soluble iron compounds.

Copper

Copper is considered one of the minor plant nutrients. The average copper content of a wide variety of plants, as shown in Table 1, is very low, only 11 parts per million of the dry matter of plants. The very small amount required by most plants probably accounts for the fact that early experimental cultures failed to show that copper is an essential element for plant growth.

Soils high in organic matter, particularly newly cultivated peat soils, are most likely to have a deficiency of copper. Copper deficiency is most likely to occur on mineral soils formed under acid conditions where the relatively large quantity of strong anions such as sulphates, nitrates, and chlorides results in the solubility and the leaching of copper from the soil. Peat soil relatively high in calcium is most likely to show a deficiency of copper, as the high calcium content of the soil would favor the formation and accumulation of nitrates in the soil. The data in Table 2 show that copper nitrate is highly soluble, which would result in much of the available copper in the soil being lost through leaching. Under some conditions the copper in the bordeaux sprays was sufficient to supply the copper requirements of certain tree crops on certain soils. Where a relatively low amount of copper is found, it may be desirable to apply copper sulphate to the soil. Soils with a relatively high pH value will fix relatively large quantities of copper; whereas, on acid soils much of the copper added to the soil may remain soluble and be toxic to certain plants.

Applications of Minor Metallic Nutrients

Where the pH value and the concentration of the hydroxyl ions are not too high in the soil, it is usually satisfactory to apply soluble salts of the minor nutrients. An annual application of 25 to 50 pounds per acre of sulphate, chloride, or nitrate of manganese, zinc, iron, or copper will usually supply the nutrient requirements of most plants. On alkaline soils or soils which have received a heavy application of lime, the intensity of absorption of the weaker ions may be very low, which makes it difficult for the plants to secure enough of these nutrients for optimum growth. Under such conditions the application

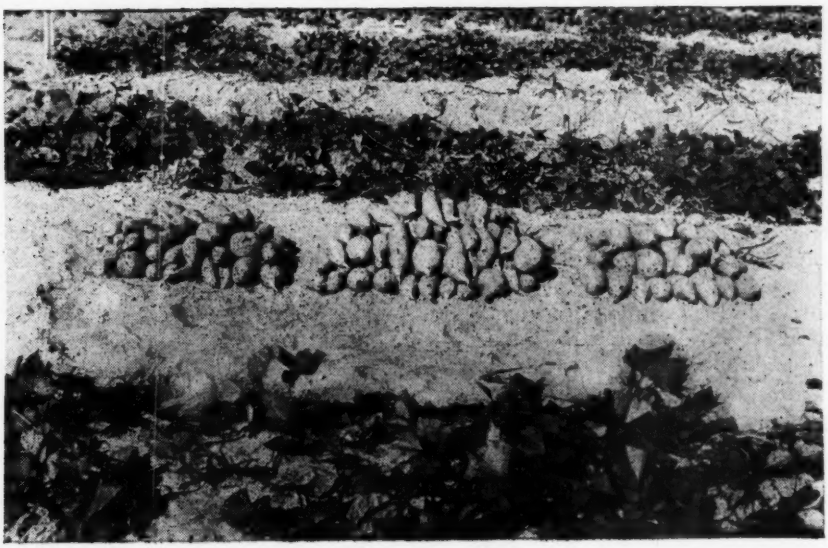

Fig. 3. Yields of No. 1 sweet potatoes from applications of boron. Left, none; center, five pounds; and right, ten pounds of borax per acre. The yields per acre of marketable potatoes for none, five, and ten pounds of borax per acre were 153, 235, and 186 bushels per acre, respectively.

of these nutrients as a spray to the foliage may be the most effective means of supplying these nutrients to some plants. It has been determined that driving zinc nails into certain trees supplies the zinc necessary for their growth.

Use of Basic Slag on Acid Soils

Under most acid soil conditions the use of 1,000 to 2,000 pounds per acre of Birmingham basic slag and an application of 5 to 20 pounds of borax per acre will supply the minor nutrients needed by most crops. Under certain conditions it may be desirable to add 25 to 50 pounds of copper sulphate per acre. Where two or more minor nutrients are deficient, an application of basic slag is often the most economical and satisfactory way of supplying most minor nutrients. Heavy applications of basic slag are not satisfactory on soil when it is undesirable to significantly change the soil reaction.

Summary

1. It is now generally accepted that a large number of elements may be effective in the nutrition of plants. The nutrients are sometimes classified as major nutrients including the three primary and the secondary, and minor nutrients, depending upon the significance of the various nutrients utilized by plants grown under different conditions.

2. The major nutrients in plants are commonly expressed as per cent or parts per hundred; whereas, the minor nutrients are often expressed as parts per million rather than as per cent of material.

3. Since there is a definite quantitative relation between the intensity of absorption of nutrients and the relative strength of ions, the relatively weak minor nutrient ions do not constitute a large proportion of the mineral nutrient requirements of plants.

4. The energy properties of nutrient ions largely determine the intensity of absorption of different ions by most plants.

5. In mixed fertilizers the quantities of nitrogen, phosphorus, and potash are guaranteed. With the exception of bright leaf tobacco fertilizer, there is

usually no guarantee of the quantity of sodium, calcium, chlorine, or sulphur, which also form relatively strong ions, may be absorbed in relatively large quantities, and may have a major role in the nutrition of plants under certain conditions.

6. The mixed fertilizers may or may not contain significant quantities of the secondary elements depending upon the types of materials used in making mixed fertilizers.

7. The minor plant nutrients such as manganese, zinc, iron, and copper, which form relatively weak ions, are usually not utilized in large quantities by most plants.

8. Alkali, over-limed, and strongly acid soils are most likely to be deficient in minor nutrients.

9. Soils with a relatively high pH value, or low soil acidity, are most likely to be deficient in available minor nutrients, due to the formation of relatively insoluble carbonates and hydroxides of these minor nutrients in the soil.

10. The addition or the presence of a relatively large quantity of phosphorus in the soil may decrease the solubility and availability of the minor nutrients, by forming relatively insoluble phosphate compounds.

11. On soil with a low pH value, or high soil acidity, there may be adequate or toxic amounts of the minor nutrients soluble and available to plants. The presence in relatively large quantities of the strong anions such as sulphate, chloride, and nitrate ions increases the solubility and availability of the minor nutrients in the soil.

12. When minor nutrients are applied to soils in combination with fertilizers, it is usually desirable to utilize the soluble compounds such as sulphate, chloride, and nitrate.

13. Boron is very probably more deficient than most of the other minor nutrients, in the Southeastern states.

14. Heavily limed soils are most likely to be deficient in boron.

15. Such crops as alfalfa, beets, turnips, carrots, potatoes, and cotton often show marked yield responses to an application of boron.

16. Since excessive quantities of soluble boron may prove very toxic to certain plants, it is highly desirable to be extremely careful in the inclusion of large quantities of boron in mixed fertilizer. The optimum quantity of boron for different crops may vary from the equivalent of 5 to 20 pounds of borax per acre.

17. Due to the increased use of limestone on Southern soils and the resultant widespread boron deficiency in many of the soils, it is highly desirable to include boron in fertilizer for most of our crops. It is not likely that the inclusion of 10 pounds of borax per ton of fertilizer would be an excessive amount for most of the soils in humid regions where 1,000 pounds or less fertilizer per acre are applied. Where the fertilizer application is a ton or more per acre, not more than 5 pounds of borax per ton should be included in the fertilizer mixture for most crops.

18. Due to the widespread deficiency of boron on many of the limed soils and the low cost of adding the borax, it is strongly recommended that prophylactic quantities of boron be added to all mixed fertilizers to be used in this region.

19. Where such nutrients as manganese, zinc, iron, or copper are deficient, the addition of 25 to 50 pounds per acre of the soluble compounds such as sulphate, chloride, or nitrate of these materials in advance of planting will often supply adequate quantities on acid soils.

20. On soils with a high pH value and a high hydroxyl ion content, the solubility and availability of the minor nutrients may be very low. The low intensity of absorption and the low mobility of these ions in the sap of the plant may make it necessary to apply these nutrients as a spray to the foliage, particularly to certain tree crops where it is necessary for the nutrients to diffuse through the plant sap to the leaves of the trees.

Whole-farm Demonstrations

(*From page* 10)

strations the hundreds and thousands of demonstrations and experiments carried out had shown positive evidence of a great need for potash. On many soils highly profitable responses to treatment with potash fertilizers were shown. In fact, on certain soil types the low level of available potassium appears now to be even more responsible for legume failures and poor yields of grain and corn than the low level of available phosphorus. Fully 75 per cent of our Wisconsin soils need a combination of both phosphate and potash fertilizers in order to make possible maximum yields of legumes and other crops.

Through our livestock and dairy systems of farming we have lost thousands of tons of potash in the wasteful and careless system of handling stable manures. There are soil type areas representing millions of acres in Wisconsin where apparently the supply of available potassium was short even in the virgin state.

In our program of whole-farm test demonstrations we started out with a full recognition of the importance of potash. We wanted to make sure at the outset that fields being seeded to legumes received the proper balance of plant-food nutrients the first year. The need for potash, phosphate, and lime was first established by soil tests.

In our test demonstrations we always leave a no treatment strip across the entire length of the field. Adjacent to this check plot we have made a practice of putting in a strip with phosphate only, and in some cases potash only. In this way, we have proven to the farmer the need for both potash and phosphate and the almost universal need for both.

What do the cooperators have to say about the transformations they see on their farms? Well, you can imagine what anyone would say when the yields of grain are increased by 50 per cent and the yields of hay the year following are doubled.

Here is a typical story of one of these transformations. Frank De Chant bought a run-down, badly neglected farm of 160 acres in Glendale Township, Monroe County, Wisconsin, in 1941. The sale price to him was $7,500. The purchase of this farm was financed through the Farm Security Administration under the tenant purchase plan. Neighbors told him he would fail; every farmer, they told him, for many years previous who had tried to make a living off this place had failed. But Mr. De Chant, by good fortune, started out as a TVA cooperator. Lime and fertilizer were applied that first year according to soil tests. On most fields which were seeded to alfalfa he applied the equivalent of 500 pounds of 0-20-20 per acre. Yields of grain were increased a good 50 per cent and seedings of clover made a luxuriant growth in the stubble that fall. The year following he filled his haymows to overflowing with protein-rich legume hay.

Mr. De Chant has paid for this farm within a period of six years. But that's not all, for during these past six years he has purchased more than $10,000 worth of farm machinery and other new equipment, bought a new car, put over $1,000 into improvements on his barn and home, and they are all paid for. His yields have been more than doubled every year (by comparison with check plots) and not only more feed but better quality feed has been produced. This past year he had so much hay that his two barns would not hold it and so he sold a considerable tonnage of baled hay direct from the field to his neighbors.

This may be an exceptional case but there are literally hundreds of TVA cooperators who will tell you similar

stories. When you boil their stories down to the one underlying factor most responsible for their success, these farmers will tell you that liberal treatment with fertilizers and lime did it. A farmer must feed these good crops to good cows and in turn follow a program of crop management and soil erosion control.

But the opportunity for increased income and better living through the more generous and liberal use of lime and fertilizers is just now unfolding itself to Wisconsin farmers. The 300,000 tons of fertilizer used on Wisconsin farms in 1946 should be doubled if we are to break even on a soil fertility balance sheet for the State as a whole. Farm prices for the past five years have been a big factor in this greatly expanded use of fertilizers, but it is true also that our Wisconsin farmers have learned by their own experience that it pays to fertilize.

Education through our system of agricultural extension, through the medium of the teaching and training of the boys in our high schools by the Smith-Hughes teachers of vocational agriculture, the help—direct and indirect—rendered by the allied educational bureaus supported by the fertilizer industry, the impetus given to soil conservation practices by our Federal action agencies, and the greatly expanded program of whole-farm test demonstrations supported by the Tennessee Valley Authority—all of these have played a part in this re-awakening of the farmer and the general public in matters pertaining to practices of soil-building and conservation.

This period in our nation's history may go down as the great soil conservation era. Soil science has come into its own. Teacher, preacher, doctor, writer, banker, industrialist, business man, and even the layman seem to have caught the surge of this great movement. "Notre sol est notre patrie. Protéger l'un est servir l'autre," and as the French people say: "Our soil is our country, to save the one is to save the other." We have made a good start in the direction of better land use, soil conservation, and fertility maintenance in Wisconsin. Extension education in soils directed by college specialists and carried out by county agents and Smith-Hughes teachers, all of us working together with the Federal action agencies of the USDA, TVA, and the educational bureaus set up by the fertilizer industry, can do a good job.

For Better or Worse

(*From page* 5)

me (early in their marital career) that they love the clinging-vine-and-the-sturdy-oak type of union; that the face and form of the wife is worth more than her managerial skill, and all that kind of tripe. While there is nothing to prevent a smart pin-up girl from being a bang-up wife, I always advise them with the goodness of an uncle to beware of looks when picking cooks.

No, I have never regretted the fact that my good frau is independent and resourceful. She can outthink me and outmaneuver me with zest and great ability when the proper time arrives. At other less important occasions she defers to my wisdom and my experience and good judgment, thereby making me feel right smart and proud over a minor victory.

In some romantic fiction and books on social history, the householders and parents of the past century are made to appear paragons of steadfast virtue and of unremitting and unselfish toil.

Some agencies have done this with a purpose. Even our own parents sometimes pointed back to other years of sacrifice and renunciation, devotion to stern duty, and small and fleeting pleasures.

It would seem as though they stood, as it were, on the dividing line between the era of self-control and good family deportment and the loose and easy-going epoch of our modern domestic life. They were "the last of the Mohicans" prior to the advent of the jangle and jumble of irresponsible marriages and woeful neglect of parental responsibility.

YET in my own way of thinking about it, there are more pressures, more distractions, and more obstacles facing the pater and mater familias and their children since our country has attained "middle-aged" affluence with its high and complex standards, than the couples of the coonskin and calico period had to plague them.

Under a democracy like ours, now at the world's zenith of power and possession (outwardly anyhow), the glitter is hard on the mental eyesight, the hurry and worry is conducive to snap decisions and regrettable consequences, while the dwindling dollar of the lower-bracket boy makes it difficult for him to give his family the privileges which are advertised as part of the customary American pattern.

None of us who have slowly and painfully climbed along the steep incline in double harness would want to dump the load behind us or remove our sights so firmly fixed on the levels of living which seem to be attainable at the cost of a little more sweat and endurance.

To be sure, there are no lurking aborigines or wildcats ready to scalp us or rip us limb from limb, nor any wilderness in which to lose ourselves and our tearful progeny. Yet there are other no less troublesome and frustrating destroyers and annoyers of the soul's peace and solace ready to challenge pa and ma and their offspring today. Even without the atomic menace.

We must, of course, recognize that the family guardians of the past did not enjoy the regular advice and suggestions of the daily newspaper "lovelorn" writers or adjusters of mental quirks. Our grandparents had no chance to be psychoanalyzed, to be put wise to many primal needs of human nature, and to be warned against vagaries of behavior on the part of husband, wife, or mother-in-law. They had no frank books on biological aspirations and activities—only a backhand and misunderstood reference to our relationship with the apes. Romantic novels were prim and prissy, all prunes and prisms, and very little harsh reality.

The Dads of former times made regular trips to the woodshed with recalcitrant urchins, but they did not go there to whisper to them all the sneaking facts of life. I presume Mothers did a trifle better job in that line than the Fathers did, strictly in confidence to the girls. Of this I cannot speak firsthand.

But today the parents find it hard to keep up with the youngsters in acquiring substantial knowledge of physical elements and the subversive social practices of the times. They get hep to things both through the old grapevine, undercover route, and the more up-to-date systems found in many magazines and library references. All of which makes the parental job of education less irksome but renders the job of supervision even more trying.

ONE of the duties of a married couple which is often wholly overlooked lies in the need for them to train themselves and their children to assume a share of community interest and responsibility. In the age in which we live, when taxes on real estate in some high assessment areas run to a dollar a day or better, plus interest and upkeep on the shelter alone, it is easy to neglect public affairs and neighborhood

zeal so as to make ends meet at home.

There must be a happy medium somehow wherein the family can take part in events and programs and be co-operative beyond their borders and thereby gain confidence and bring the kids up in the right attitude toward others. Since the coming of modern equipment and facilities there is little excuse even for the remote rural family to be shy and aloof, bringing up their offspring in a suspicious and selfish way.

I confess that in our family it has been Ma who has taken the lead in this respect, seeing to it that the youngsters partook of many duties and privileges of citizenship and neighborhood and school relations. I have not been one of those carefree and convivial chaps who took keen delight in being a "joiner" and a back-slapping good-fellow. Often I have regretted my disinclination to wear goofy hats, march in long parades, and learn to sing the anthems of local or fraternal superiority. Hence it devolved upon the Better Half to coax us all into communal reunions and see that we did our share of the decorating, errand running, and program planning.

THEN when the Big War clouds gathered, all petty intimate family preferences had to yield to the larger and more portentous obligations that carried us far beyond the confines of our community, and projected us in one way or another into realms and regions which we had forgotten since our last examinations in geography. Maybe it happened just when we needed to be stirred and resurrected from provincial inertia into awareness of limitless horizons and the brotherhood of man. I was not so doubtful of the immediate results on our family attitudes during the war era itself as I have been since we began to "write the peace."

This present season of international adjustments finds Ma and me up a stump. Luckily, the kids have grown beyond our daily direction and are thinking for themselves more than ever. I say "luckily" because we are badly sidetracked, seeing no chance to get back on the main trunk line while the red and green semaphore signals are so badly mixed. We are beset with too many confusing voices and contradictory authorities.

FROM our own family experiences we know that up to a certain point a dose of sound appeasement and compromise keeps the household and its occupants satisfied and agreeable. Yet we haven't been able to succeed too well when we allowed some mean neighbor or selfish member of the family to pursue a narrow coarse unchecked and unbridled. But the real trouble is that we are obliged to sign away the future in a broad sense to a few officials and their opinions and judgment, and all a humble householder and taxpayer can do is to hope and pray that the leaders are endowed with sanity and balance. Like the late lamented Will Rogers (who kept us courageous and calm) most everything we know in the world today is what we read in the papers. I sometimes wonder if the papers sense this responsibility to so many quiet couples on the back streets.

You may think this is all getting a pretty "fur piece" outside the field of wedded life and marital duties. However, I am foolish enough to maintain that modern parents must assume some degree of interest in events which shape the lives of themselves, their kids, and the rest of the community. Our grandparents could run away from tight situations, and many of them did so—trekking westward to fresh fields far distant from the bothersome details besetting the older colonies. But there "ain't no place" to run to any more. We're stuck in our tracks. Moreover we are now citizens of Paris and Berlin and Prague—and some even aver, of Moscow. The whole blamed world has caught up with us. This is the price we pay for being so terrificly smart and amazingly versatile and scientific.

While we are trimming up the bandstand or the schoolhouse at our community festivals we must be thinking in big terms of the hungry bellies of babies abroad and what would be the lasting effect of feeding some of them or letting the whole tribe starve, for all we care. No such posers throttled us when we were young. We strutted our stuff on our own stage and shut the rest of mankind outside.

One might assume that in this present dilemma the returned veteran on the next street to ours might allay our fears and unravel our twisted skeins of thought on world affairs. We thought so a few months ago, trusting to the power of personal observation and judgment by one of our neighbors to set us aright. But Ma and I haven't been able to pick up many crumbs of comfort or get wiser to what ails the universe by peppering him with questions. Even my son-in-law who partook of certain dangers and discomforts abroad speaks, when he speaks at all, in the blue language of tough skepticism. So we just sit it out and wonder if that new grandchild will live in a better or a bitter world—and why in tarnation we couldn't have done something more effectively to guarantee reasonable hope for all such unfolding personalities.

IN conclusion, then, I still adhere to my thesis that the married folks of the present day really take on a carload of burdens and duties when they clasp hands and go in for "better or for worse." Pioneer hardships of former times have a counterpart today, and believe me, I take off my bonnet to any couple who weathers the storm and keeps the old home craft right side up.

And more especially to those who do so under sorrow and sickness, loss of employment, or disability. When they start handing out more medals let's distribute a few to the householders who kept those home fires burning and the rent paid while heroes and statesmen "wrote the peace."

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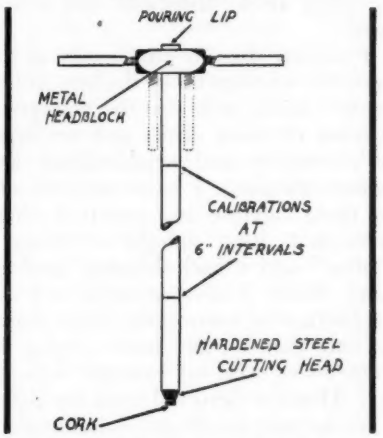

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MISUNDERSTOOD

Several men were traveling by train. Presently one produced a large fruit cake, which he devoured greedily.

Time passed. Suddenly he began groaning and doubling himself up and straightening out again. When this had gone on for some time, a friend asked him:

" 'Smatter, Jim?"

"That cake I ate," groaned the sufferer. "It had nuts, and I think the missus forgot to shell them."

"Lor!" said his friend. "And can you crack 'em just by bending?"

"Have you noticed how untidy Old Maid Jones' house has become lately?" asked the first gossip.

"Yes," replied the second, "ever since the minister said, 'Man sprang from dust,' she quit sweeping under her bed."

SHE WAS A BELIEVER

A negro spinster of uncertain years decided at long last to join the Baptist Church. As the deacons plunged her into the river the first time, she gasped, "I believe." The second time she chattered, "I believe." A third time, gulping for air, she sputtered, "I believe." One of the elders interposed: "You believe what, sister?" She eyed him savagely: "I believe you stinkers are trying to drown me."

A Washington diplomat was entertaining a French official. The official had difficulty with the King's English. He expressed his thanks for the kindness of his host, but added apologetically:

"I'm so sorry to cockroach on your time."

"Oh," answered his host, "think nothing of it. But you don't mean cockroach, monsieur; it is encroach, you mean."

"Oh, is it? I see—a difference in gender."

A recession is a period in which you tighten up your belt. In a depression you have no belt to tighten up—and when you have no pants to hold up, it's a panic.

"Be careful of a live wire when you're in the bath tub."

"Oh, I am. I always lock the door."

A neighbor, passing the cabin of a mountaineer, had the bad fortune to run over and kill the mountaineer's favorite dog. He went into the house and told the man's wife what had happened and how sorry he was. The owner of the dog was out in the fields, and the motorist decided he had better go out and tell him of the accident, too.

"Better break it to him easy like," said the wife. "First tell him it was one of the kids."

Need for—

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THE PLANT SPEAKS, SOIL TESTS TELL US WHY depicts taking soil samples on the farm and the interpretation of soil tests. (Running time 10 min. on 400-ft. reel.)

THE PLANT SPEAKS THRU TISSUE TESTS shows the value of tissue testing and the procedure for testing plant tissues in the field. (Running time 14 min. on 400-ft. reel.)

THE PLANT SPEAKS THRU LEAF ANALYSIS evaluates leaves in plant growth and leaf analysis in determining fertilizer needs. (Running time 18 min. on 800-ft. reel.)

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Potash Deficiency in Grapes and Prunes (West)
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Requests should be made *well in advance* and should include information as to group before which the film is to be shown, date of exhibition (alternative dates if possible), and period of time of loan.

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